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THE LARGEST MECHANICAL CIRCULATION IN THE WORLD

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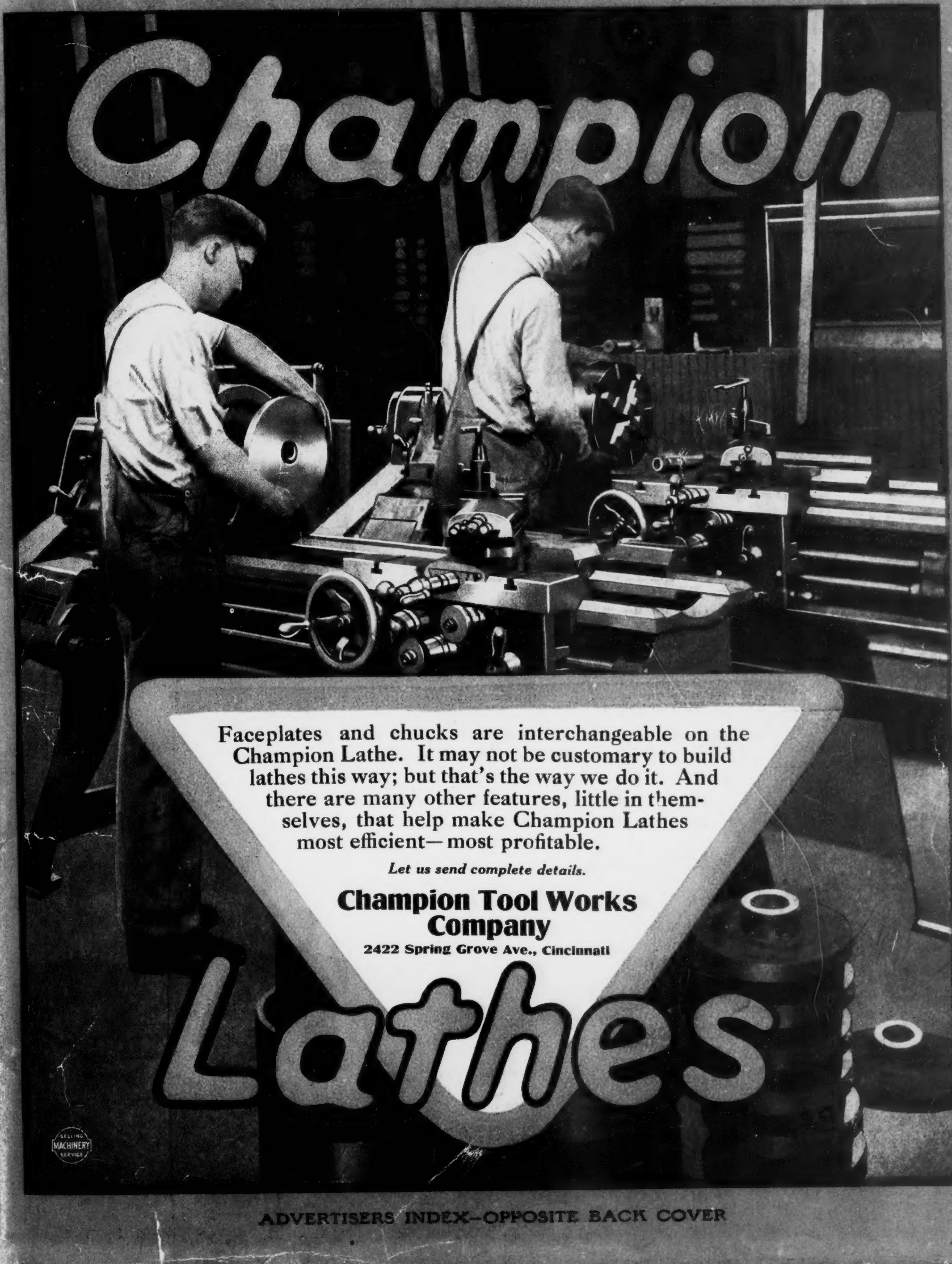

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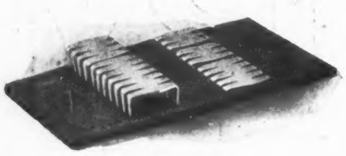

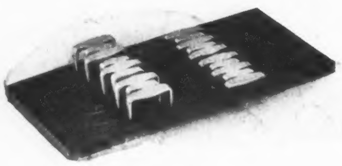

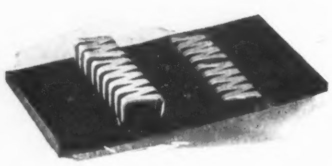

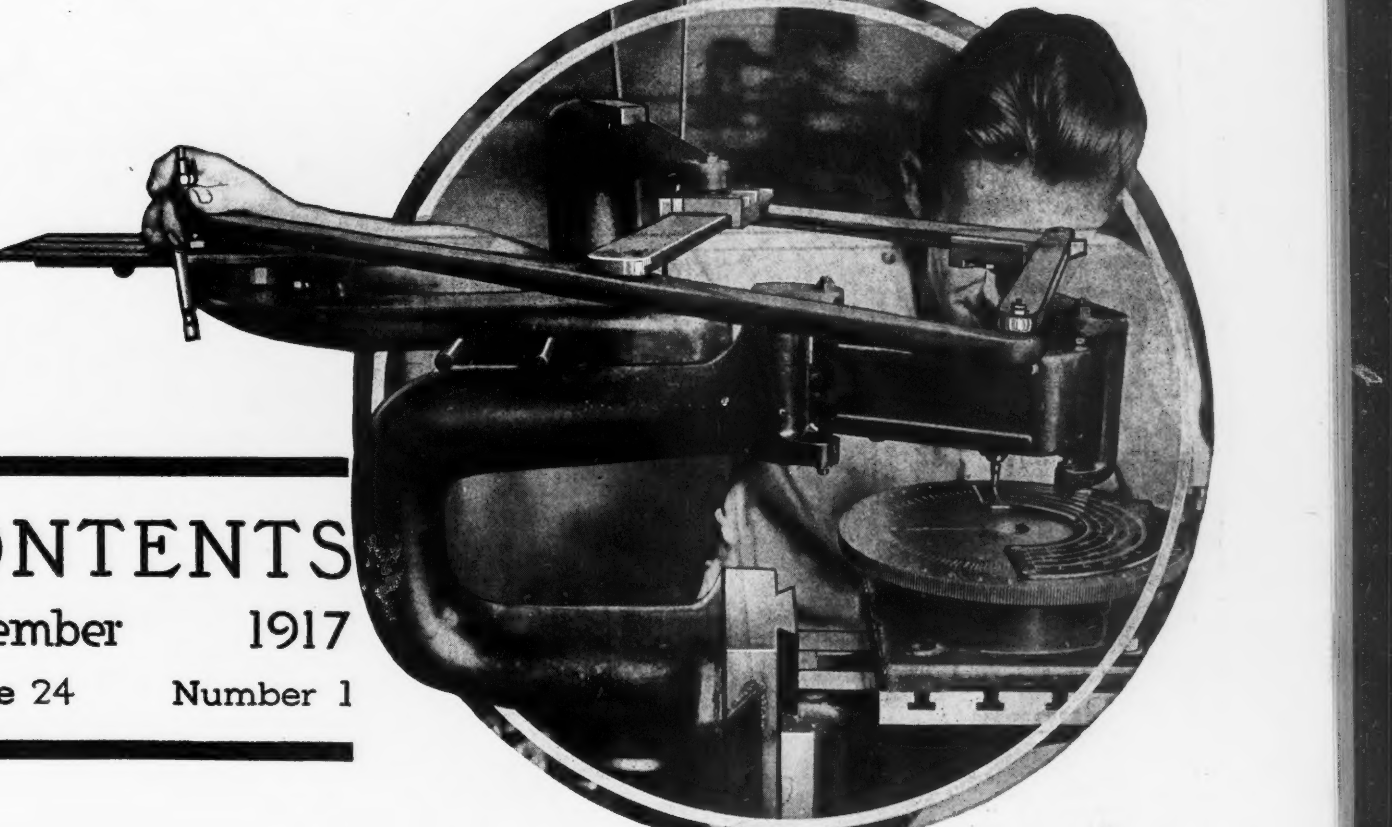

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September 1917

Volume 24 Number 1

Graduating, Engraving and Etching

by Franklin D. Jones[1] and Edward K Hammond[1]

CUTTING graduation marks and figures that indicate the values of successive graduations may involve three distinct operations. Graduation marks may be cut directly in the metal, or an acid "resist" may be applied to the steel and the graduation marks cut in this protective coating. Where the latter method is employed, the marking of the graduations is done by immersing the work in acid so that the surface of the metal from which the resist has been removed by the graduating tool may be "cut" by the etching solution. In any case, a graduated scale would be incomplete without figures to indicate the values of successive graduations, and these may be cut in several different ways. The simplest method would be to cut the figures by hand, but such a procedure would involve considerable time and expense. A better way is to either do the work on an engraving machine, the operation of which is controlled by a pantograph mechanism and master copy, or to use a graduating machine which is designed in such a way that it can also be used for cutting figures and other irregular designs, such as trademarks, etc. As in the case of cutting the graduation marks, the figures may be cut directly in the metal or they may be cut in a protective coating applied to the metal and etched by immersing the work in acid. Similar methods may be employed for trademarking the work, but where there is a considerable amount of detail in the design it may be more economical to use certain labor-saving methods, to which reference will be made later. It is the purpose of this article to give a comprehensive description of various methods of graduating, engraving and etching, and to explain the different classes of work for which each of these methods is especially adapted.

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In shop parlance some confusion exists as to the use of the terms graduating, engraving and etching. These operations are decidedly different, but as the same general result may be obtained by graduating or by a combination of graduating and etching, and by engraving or by a combination of engraving and etching, these terms have come to be used interchangeably, which is incorrect. In this article information is given concerning modern practice in performing these three methods of marking, and the kind of work for which each is adapted.

Methods of Graduating

The degree of accuracy required in graduating varies considerably with different classes of work. The instruments used in connection with astronomical observations require the greatest degree of precision obtainable, while the graduations on surveying and nautical instruments, machinist's and toolmaker's scales and protractors, and similar tools and instruments, do not require the extreme accuracy of the astronomical instruments, although such graduations must be very accurate. The type of machine or tool used for graduating and the method of producing the graduation marks or lines varies with different classes of work, depending upon the degree of accuracy necessary and the form of the parts to be graduated. The extent to which graduating is done or the quantity of work handled may also affect the type or design of the machine or tools used. The work of graduating may be divided into two branches—the method of spacing, and the means for making suitable marks or lines upon the parts to be graduated.

Spacing Methods

The machines used in laboratories and by tool and instrument manufacturers, for graduating various kinds of straight scales, may be classified as the precision screw type and the pantograph type. The former is equipped with a very accurate lead-screw, which, by means of an indexing or spacing mechanism, is rotated an amount depending upon the spacing required, and as this screw actuates the work-holding table, a tool that is given a cross-movement makes graduation lines either in a "resist" or directly upon the work. The pantograph machines have a pantograph mechanism which serves to reproduce, on a smaller scale, the graduation lines or figures that have been previously cut in a pattern or master scale. Machines of the two general types referred to are generally

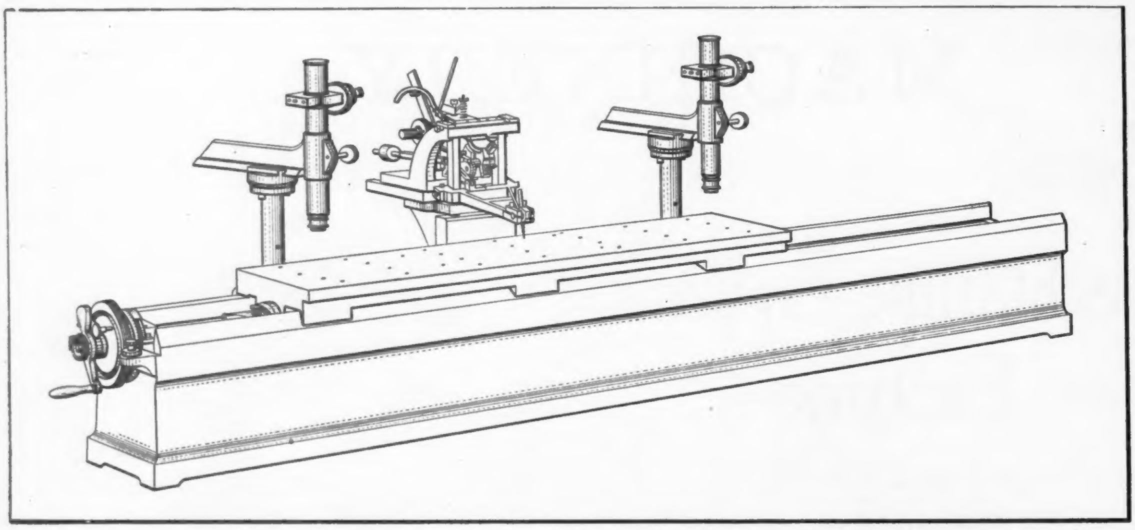

Fig. 1. Hand-operated Linear Dividing Engine or Graduating Machine of Precision Screw Type

used for linear graduations, although some designs are also adapted for circular graduating. A design intended especially for circular work has an accurately cut worm-wheel connecting with a circular work-table, and a meshing worm which is rotated by an indexing or spacing mechanism, in accordance with the circular spacing required.

Formation of Graduation Lines

The marks or lines which represent divisions or spaces on graduated scales, etc., may be formed by the etching process, by the direct-cutting action of a tool, or, for some grades of work, by the stamping or impression process. With the etching process, the part to be graduated is first covered with some acid-resisting material or "resist," as it is called, and then the lines or figures are cut into this resist by a mechanically guided graduating tool, thus exposing the metal wherever these lines or figures are made. An etching acid is then applied, and, wherever the metal is exposed, the acid eats into the surface and forms the division lines. When very fine graduation lines are needed the general practice is to employ the direct-cutting method, since the marks obtained by a very sharp-pointed tool are finer and more accurate than can be obtained by the etching process. There are two general types of cutting tools, one of which operates with a plain draw stroke, whereas the other is a rotary tool and revolves at a speed of about from 8000 to 10,000 revolutions per minute. Diamond points are also used for cutting very fine graduation lines, the diamond being drawn across the work without a rotating movement.

Screw Type of Linear Graduating Machine

A linear dividing or graduating machine of the screw type, which is adapted for precision work on scientific instruments or for other work in which a high degree of accuracy is necessary, is shown in Fig. 1; and Fig. 2 illustrates a power-driven machine of the same general design. The bed of this machine is provided with planed ways upon which a work carriage is mounted. This carriage is traversed by a lead-screw located inside the bed, and in the case of the hand-operated machine, this screw is turned by the small handwheel at the left-hand end of the bed. After each movement of the carriage has been completed, a tool supported by the tool-head at the back of the machine makes a graduation mark on the work which is secured to the carriage. The handwheel at the end of the lead-screw is provided with a graduated dial, each space of which corresponds to 1/200 millimeter. Secured to the handwheel is an adjustable stop which may be set to obtain the required distance between consecutive graduation lines. This stop engages cams at the front and back of the handwheel, which are brought into position to engage the limit stop, by means of a thread on the circumference of the handwheel meshing with small worm-wheels that actuate the cams. The engagement of the thread on the handwheel with the worm-wheels may be so adjusted that the limit stop comes into contact with the cams after part of a revolution of the handwheel or after more than one complete revolution, according to the requirements of the work.

In operating the machine, the handwheel is turned back until the stop comes into contact with one of the cams. This backward movement is effected without turning the lead-screw on the machine; then the handwheel is turned forward and in this direction a ratchet and pawl causes the lead-screw to be locked to the handwheel so that the screw is turned, and advances the carriage and work until the limit stop comes into contact with the cam at the opposite side of the handwheel. When this position has been reached, the operator pulls forward a small hand-lever on the tool-head, which results in drawing the tool across the work and making a graduation line.

The machine is provided with means for making graduations of different lengths. For instance, it may be necessary to make each fifth graduation mark longer than adjacent marks, each tenth mark still longer, etc. On this machine, such variations in length are effected by means of three stop-screws which come into contact with a notched wheel, the movement of the tool and length of graduation mark being limited by the engagement of one of these screws with the wheel. At each stroke of the toolpost, the three sections of this wheel are advanced by means of a ratchet and pawl, and the three wheel sections may be adjusted in relation to each other so that the desired relation is obtained between the position of notches and intermediate faces on the different wheels. In this way, the stop-screws come into contact with the wheel on either faces or notches as required, thus varying the lengths of the graduation lines according to requirements. In addition to its use for graduating, this machine may also be employed as a comparator, and for this purpose two microscopes are provided which enable the position of graduations on a scale to be accurately compared with the position of graduations on a standard scale.

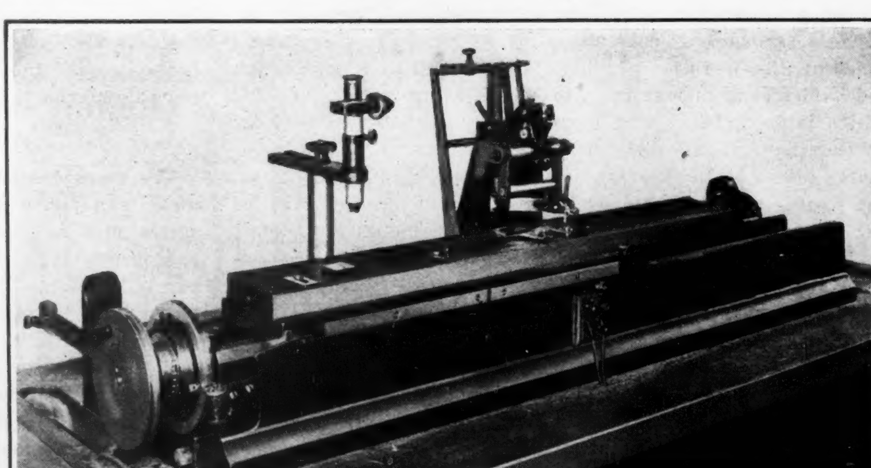

Fig. 2. Power-driven Linear Dividing Engine or Graduating Machine similar in Design to Machine shown in Fig. 1

Calibrating the Lead-screw

From the preceding description, it will be apparent that the degree of accuracy obtained with a machine of this kind is dependent upon the precision of the lead-screw. In making the machine, the greatest possible care is exercised in cutting the screw and nut, and the bearing of the nut on the screw is then perfected, as far as possible, by a lapping operation performed by introducing fine rouge or some similar abrasive into the nut. This does not provide for correcting inequalities in the lead of the thread, and, where a high degree of accuracy is necessary, the lead-screw is calibrated. For this purpose, a standard scale is mounted on the carriage, and the carriage is then advanced through suitable increments of length, as shown by the divided dial at the left-hand end of the lead-screw. After each movement of this kind, the amount of travel is noted by referring to the standard scale on the carriage with a microscope. The results obtained in this way are plotted on a chart and either of two conditions may be found: it may be that there is a uniform accumulated error extending from one end of the screw to the other, or it may happen that the error is irregular. In either case, the same method of compensation is employed. Secured to the nut on the lead-screw is a short finger extending down into the groove of a guide placed inside the bed of the machine. In the case of an accumulative error resulting in a gradual increase in the lead of the lead-screw, this guide is set at such an angle that the movement of the finger in the guide will result in turning the nut back slightly, thus compensating for the increase of lead. If the accumulative error were such that the lead gradually decreased, the nut would be turned forward in order to advance the movement of the carriage instead of to retard it. In cases where the error in the lead-screw is irregular, the lead being first too long and then too short, the same method of correction is employed, except that the guide groove is given a suitable curve of irregular form, instead of having a straight guide set at an angle.

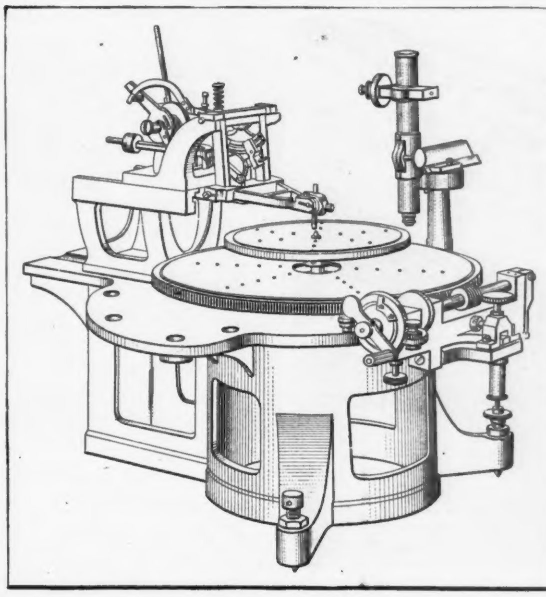

Fig. 3. Hand-operated Circular Dividing Engine or Graduating Machine

Circular Dividing Machine

Fig. 3 shows a dividing engine for use in graduating circular dials and other work of similar form. The general principles governing the operation of this particular machine are the same as for the linear dividing engine already described, except that the machine shown in Fig. 3 has been designed especially for circular work. A circular dial mounted on a pivot is used instead of a carriage traveling on straight ways on the bed, and rotation of the dial is effected by a worm which meshes with worm-wheel teeth cut into the periphery of the dial. The worm that governs the rotation of the dial is carried by a shaft, on the end of which there is a handwheel and stop mechanism for limiting the space between the graduations, this mechanism being of the same form as that described for the linear machine. The tool for performing the graduating is carried by a toolpost and head of the same form as those used on the machine for graduating straight work. Some machines are so designed that they may be used for either linear or circular dividing, there being a lead-screw for linear work and a circular table for dividing arcs or circles.

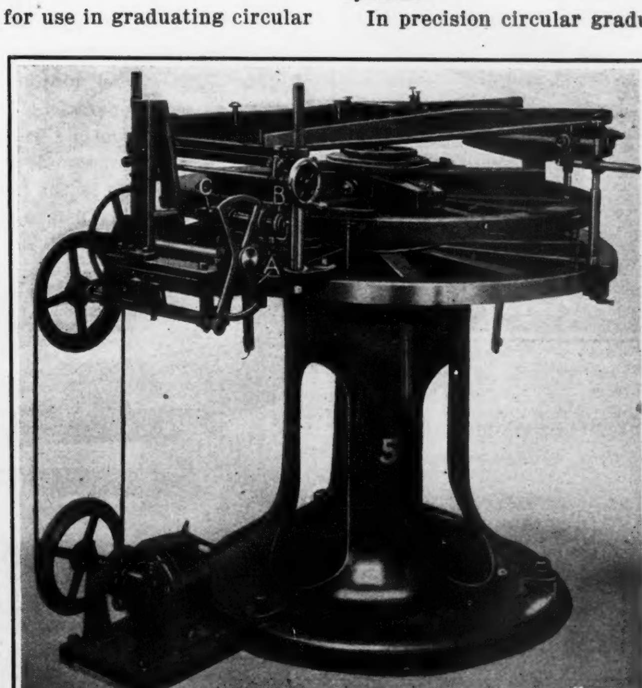

Fig. 4. Power-driven Circular Dividing Engine or Graduating Machine used in Shops of C. L. Berger & Sons

Automatic Circular Dividing Engine

For graduating the dials on sextants and other surveying and scientific instruments, C. L. Berger & Sons, 37 Williams St., Boston, Mass., have made the special circular dividing engine shown in Fig. 4. In constructing this machine, advantage has been taken of every means that would tend to give greater accuracy of the graduations on the work. For instance, the machine is housed in a room with double walls having the space between the walls packed with fiber; in this way the machine and work can be kept at practically a uniform temperature and errors due to expansion and contraction are avoided. Working with this degree of care, circular scales are graduated which are guaranteed not to have an error exceeding three seconds; in many cases the actual error is not greater than 1½ second of arc.

Circular scales are usually divided into 360 degrees; each degree is subdivided into 60 minutes, and each of these minutes is further subdivided into 60 seconds. This is known as the sexagesimal system. Attempts have been made to divide the circle into 400 degrees, *i. e.*, according to the centesimal system, thus making each quadrant susceptible of decimal division. It is difficult to apply the decimal system, chiefly because the circle with its commonly employed sexagesimal system of graduation is intimately connected with time, and this system lends itself to the making of calculations in connection with the division of hours into minutes and seconds. The degree has been decimally divided, and this has been found useful in laying down railway curves, due to its correspondence with the decimal division of the measures in use. The Berger circular dividing engine shown in Fig. 4 is adapted for graduating circles in either the sexagesimal or centesimal system.

In precision circular graduating it is of importance to have the work held in a truly horizontal plane and also to have the work concentrically mounted with the worm-wheel of the dividing engine. To secure this condition, a special form of level is used in the Berger shops, the method of employing it being illustrated in Fig. 5. This level is supported by a bracket screwed to the frame of the graduating machine, and the bar *A* that supports the level tube is pivoted to the main bracket.

At the opposite end of the bar from the pivot, it will be seen that there is a pin that bears against the surface of the work to be graduated; and after the level has been set up in this way the work is rotated in contact with the pin. Under these conditions any marked deflection of the bubble in the level tube indi-

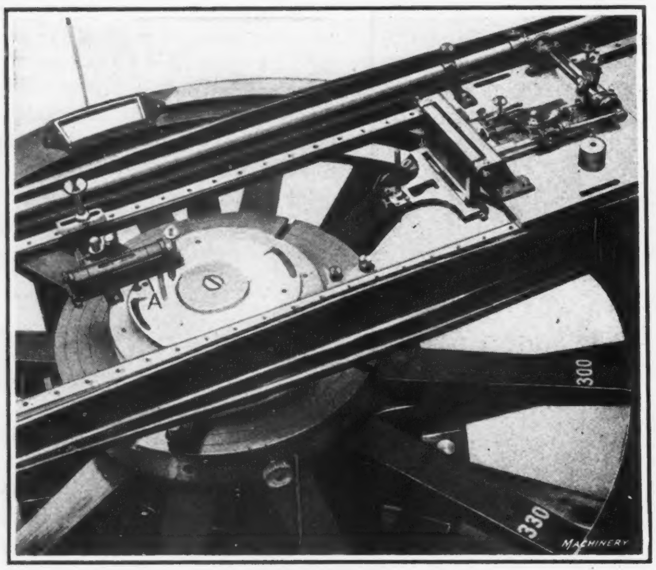

Fig. 5. Method of adjusting Work on Machine shown in Fig. 4

cates lack of accuracy in setting up the work, and suitable adjustment must be made until the test may be made without deflection of the bubble. This is a severe test because the level used for this purpose is extremely sensitive.

After setting up the work and making all adjustments of the machine, the operator leaves it and does not start the machine running until the next morning, because while setting up the work the heat of his body raises the temperature of both the machine and work somewhat above normal, and as a result there is a gradual contraction until the normal temperature is reached, which would result in introducing inaccuracies into the work. The next morning he comes into the room, starts the machine up and leaves before there is time for the heat from his body to cause any serious amount of

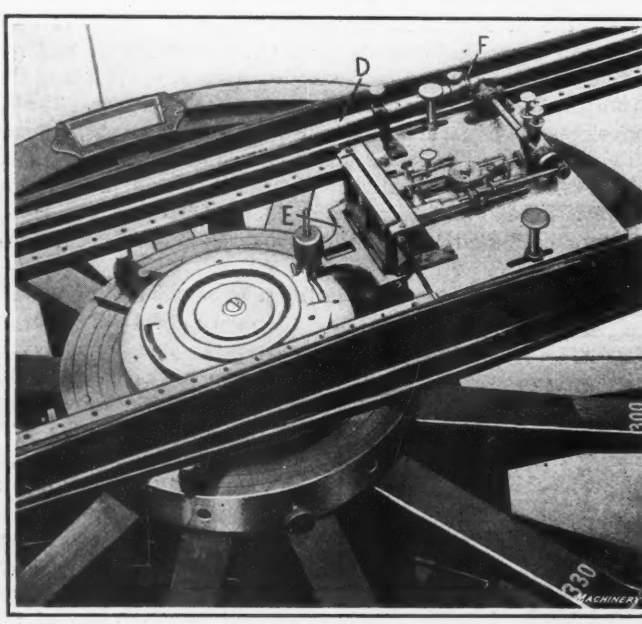

Fig. 6. Close View of Tool Carriage Mechanism of Graduating Machine shown in Fig. 4

expansion. The machine runs automatically until the graduating operation has been completed, when an automatic stop is tripped, which disengages a clutch that transmits power from the driving motor.

In this article we are interested in results rather than in machines by which these results are obtained, but a brief description of the Berger graduating machine will doubtless prove of interest. It will be seen in Fig. 4 that the drive is provided by an individual motor bolted to the floor, and the work-table is rotated by a worm meshing with worm-wheel teeth cut in the periphery of the table. Graduations are cut by a reciprocating tool which cuts on the draw stroke and is lifted clear of the work on the return stroke. It will, of course, be obvious that indexing and graduating operations take place alternately and this result is obtained as follows: From the first driving shaft power is transmitted through gearing to an intermediate shaft, on the right-hand end of which there is a double segment gear *A* which meshes with pinion *B* carried at the rear end of the shaft carrying driving worm *C*, that engages the worm-wheel on the work-table. While the segment gear is in mesh with the pinion, it causes driving worm *C* to rotate, and this indexes the work. During this time the graduating tool is idle; but when the segment gear runs out of engagement with its pinion, the work has been brought to the desired position, and at this time the graduating operation may be performed. Extending across the top of the machine is a shaft *D*, best shown in Fig. 6, which transmits power to the tool carriage *E*. The machine is used for graduating circles on dials of various diameters, and to adapt it for handling these different sizes of work provision must be made for setting the tool at various distances from the center of rotation of the table on which the work is held. This is done by having the tool carriage mounted on a slide so that its position may be adjusted as required; and to transmit power to the carriage in any position the bevel pinion *F* on the driving shaft, is so arranged that it may be slid along the shaft and secured in any position by a capscrew. This bevel pinion transmits power to a cross-shaft which, in turn, operates a link mechanism under the carriage that gives the tool its reciprocating motion. The tool cuts on the draw stroke and is lifted clear of the work on the return stroke. As in the case of the Geneva dividing engines, to which reference has already been made, means are pro-

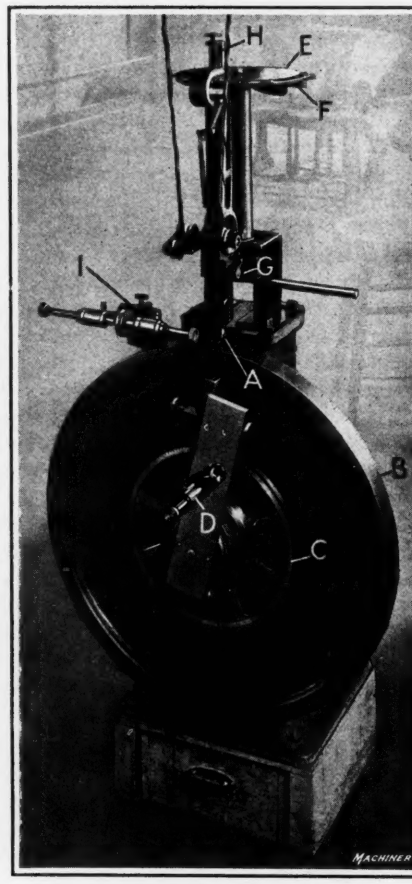

Fig. 7. Simple Circular Graduating Machine used in Instrument Shops of William Gaertner & Co.

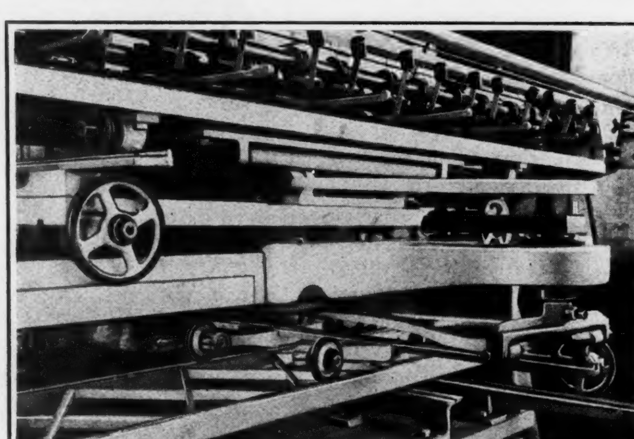

Fig. 8. Close View of Carriage that supports Control Mechanism on Hope Graduating Machine

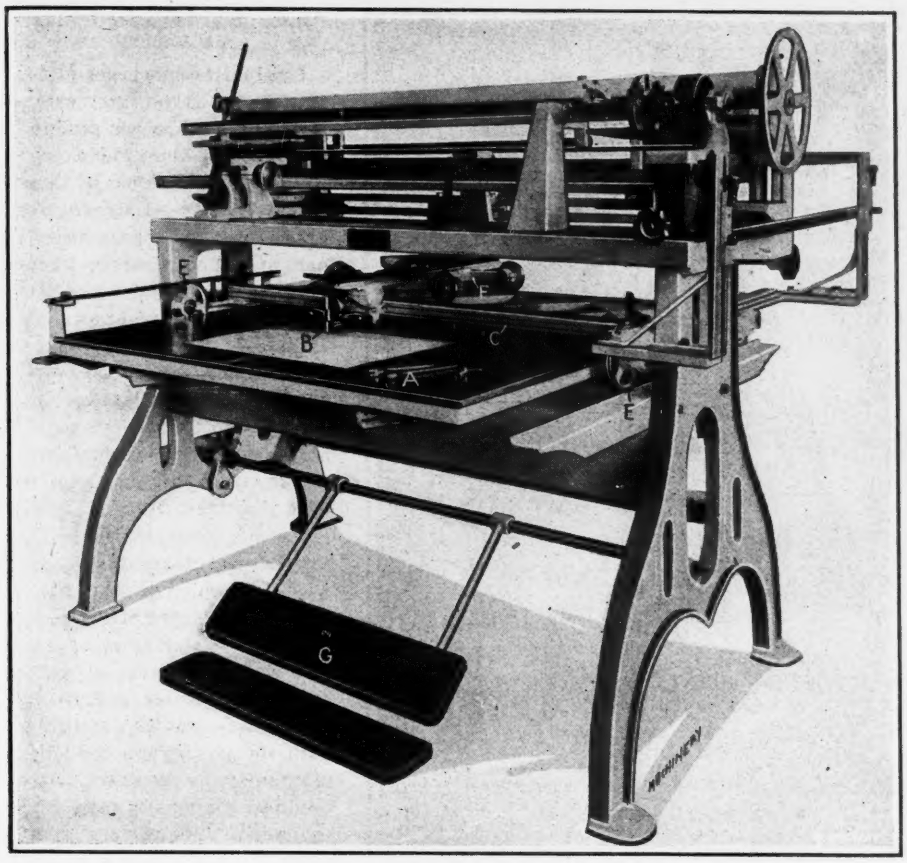

Fig. 9. Hand-operated Multiple Graduating Machine built by John Hope & Sons

vided on this machine for cutting graduation marks of different lengths at any required intervals. This is done by the same arrangement of notched wheels and screws used in the Geneva machines, operated by a ratchet mechanism.

Cutting Worm-wheel Teeth for Index Mechanism

A little thought will be sufficient to show that the accuracy of the results obtained in the operation of this machine is dependent upon the precision of the worm-wheel teeth that index the work between successive strokes of the graduating tool. These teeth are hobbed in the periphery of the work-table, and experience has shown that it is impracticable to obtain the degree of accuracy required for a machine of this kind without taking special pains to eliminate errors in the teeth that could safely be overlooked in many classes of gearing. The object is to have the worm-wheel teeth so cut that each tooth advances the work-table through the same angle.

After the worm-wheel teeth have been hobbed, the method of procedure is to graduate a circle on the work-table. Four microscopes are then mounted at equidistant points around the periphery of the table and there are cross-hairs in the eye-pieces which may be lined up with graduations on the table. Having proceeded to this point—with the microscopes lined up over the 90-, 180-, 270- and 360-degree graduations, the work-table is indexed through one-quarter revolution, using the regular worm drive to obtain this table movement. Then observations are taken, and if the worm-wheel teeth are accurate it will be found that the four quadrant graduations line up properly with cross-hairs in the microscopes which are now located over graduation marks 90 degrees from those with which they were formerly in alignment. It is more likely to be found, however, that a slight discrepancy exists in the worm-wheel teeth in the zero to 90-degree quadrant, which will be indicated by the fact that the four quadrant graduation marks do not line up accurately under the cross-hairs in the microscopes.

If this is the case it is necessary to correct the spacing of the teeth until the test can be made with satisfactory results. After this has been done, the table is advanced through another 90 degrees and observations are again made to find out if any correction is necessary in the teeth between the 270- and 360-degree graduations. This is repeated four times, and after corrections have been made it should be possible to rotate the work-table through another quadrant and find that the graduations line up properly under all four of the telescopes spaced around the table. In practice, smaller angles than 90 degrees are dealt with, but to simplify the description we have considered that not less than one-quarter revolution of the table is made between successive corrections of errors in the teeth.

Circle Dividing Machine

William Gaertner & Co., Inc., 5345 Lake Park Ave., Chicago, Ill., builds many astronomical instruments, and for graduating the circular dials required in this work, use is made of the special machine shown in Fig. 7. A variety of work can be handled with this equipment; the illustration shows the machine graduating the declination circle for a large telescope. This graduating machine is of the type on which the lines are cut by a revolving tool A, and the method of operating

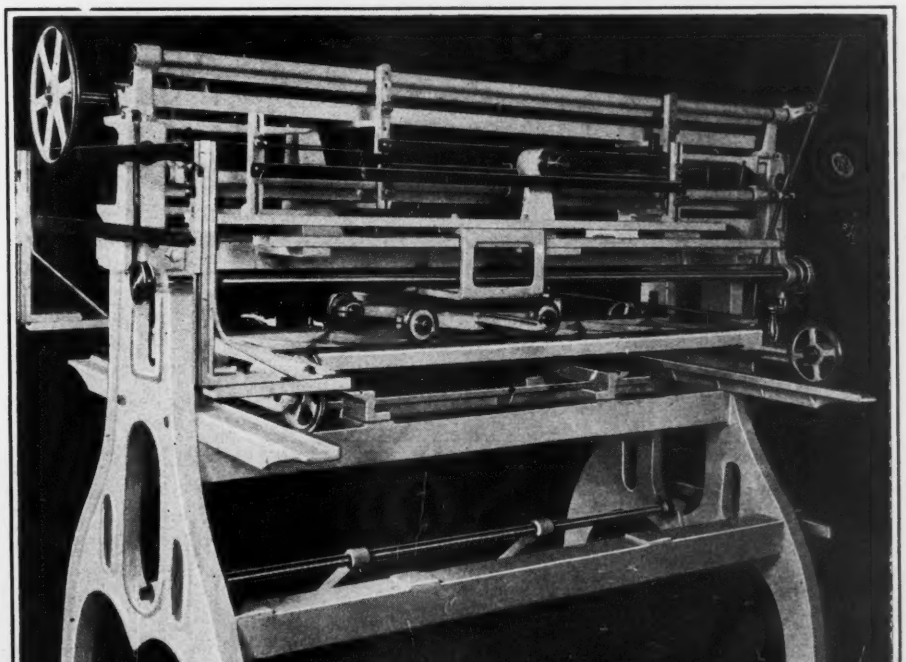

Fig. 10. Opposite Side of Hope Graduating Machine shown in Fig. 9. This Machine graduates Forty-eight Scales at a Time

the machine is as follows: Work *B* is supported on an arbor in such a way that it is free to revolve but may be secured in any desired position by tightening a quick-acting clamp. Fastened to the work there is a "master circle" *C* on which are the same graduations that it is required to cut in the periphery of work *B*. A bracket secured to the end of the arbor that supports work *B* is fitted with a telescope *D*, in the field of which is placed a cross-hair that may be lined up with any desired graduation on master circle *C*. In operating the machine, the first line is cut, after which the clamp is released and work *B* is rotated until the next line on master circle *C* comes into coincidence with the cross-hair in telescope *D*, after which the clamp is tightened to secure the work in this position ready for the next line to be graduated. This process is continued until the lines have been cut all the way around the periphery of work *B*.

As in the case of most graduating operations, it is necessary in handling this work to cut lines of various lengths, and on the present machine this is accomplished by having a master plate *E* on which are cut lines of varying lengths, which correspond with those to be graduated on the work. It will be seen that the periphery of this plate has notches cut in it to receive index plunger *F*, and each time the work is indexed by means of master circle *C* and telescope *D*, plate *E* is also rotated to bring plunger *F* into the next notch, thus locating a line of the proper length under the stylus *H*. It will be seen that engraving tool *A* is mounted at the lower end of a vertical arm, which is pivoted at *G*, the location of this pivot being adjustable so that various ratios may be obtained between the length of lines cut on work *B* and the length of lines in master plate *E*, over which stylus *H* is moved. It will also be apparent that the indexing of plate *E* is for the purpose of bringing successive lines on this plate into position for engagement by stylus *H*, thus enabling a sequence of lines of the desired lengths to be cut on the work. At *I* is shown a grinding attachment for sharpening engraving tool *A* when necessary.

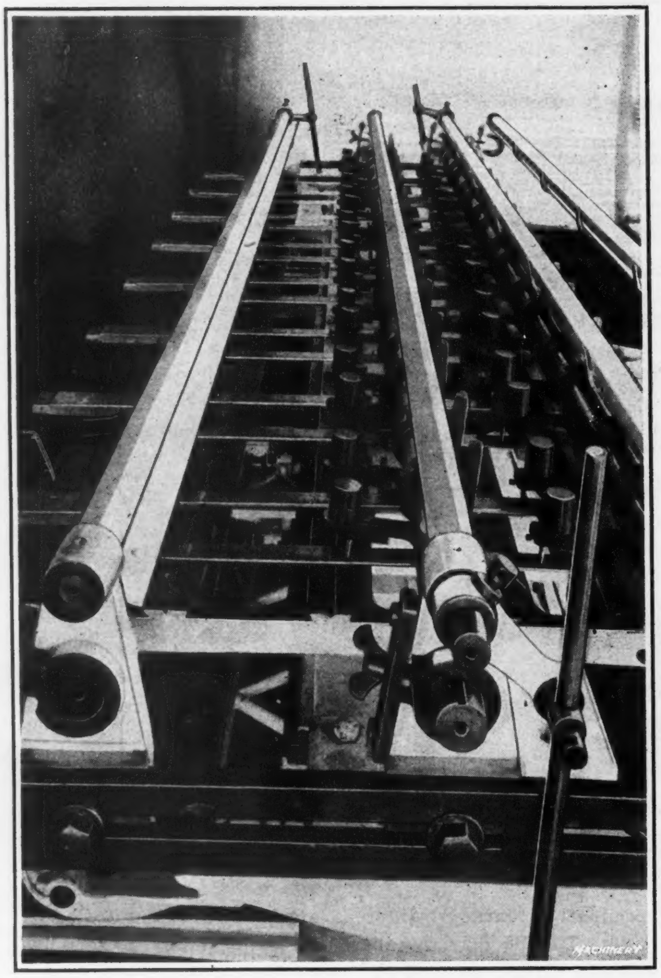

Fig. 11. Close View of Work-holders and Graduating Tools on Hope Machine

Pantograph Type of Graduating Machine

Graduating machines of the pantograph type are extensively used wherever graduating must be done on a commercial basis. Some of these machines are designed for graduating or engraving one part at a time, whereas others are intended for multiple graduation. A well-known machine of the multiple type, adapted for graduating steel rules, machinists' scales, and similar tools, on a manufacturing basis, is shown in Figs. 9 and 10. This machine is built by John Hope & Sons, Elmwood, Providence, R. I., and is so arranged that many duplicate scales or other parts may be graduated at the same time. A master scale or pattern is first made as accurately as possible and to an enlarged scale. The machine, with its pantograph reducing mechanism, is then used to reproduce this master scale onto the work. The pattern is attached to table *A* and, as the lines or figures, or whatever outline or design is to be reproduced, are followed by the tracer or pointer *B*, the movements are transmitted through the pantograph mechanism to the parts to be graduated. The tools do not cut the lines into the metal, but mark through a thin coating of acid-resisting material that has been previously spread over the surface of the work. When all the lines required have been cut into the resist, the work is removed and a suitable etching acid applied which eats into the metal and forms lines wherever the resist has been removed by the marking tools. Ordinarily, these tools or points are diamond chips, set into steel holders. The diamond chips last two or three years before repointing is necessary. Some concerns use hardened steel marking points.

When graduating steel scales on this machine, forty-eight six-inch scales may be operated on simultaneously, in which case a corresponding number of diamond points is employed. There are four work-holders, each of which has a capacity for holding six feet of work, *i. e.*, twelve six-inch scales. When the machine is in operation, movement of the tracer point *B* is transmitted to all the marking points, which are located at the top of the machine. The tracer point may be moved in any direction for following straight lines, figures, or any irregular

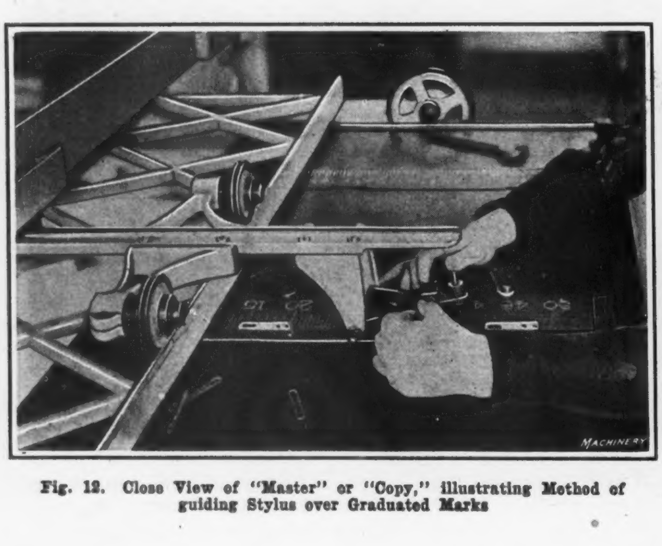

Fig. 12. Close View of "Master" or "Copy," illustrating Method of guiding Stylus over Graduated Marks

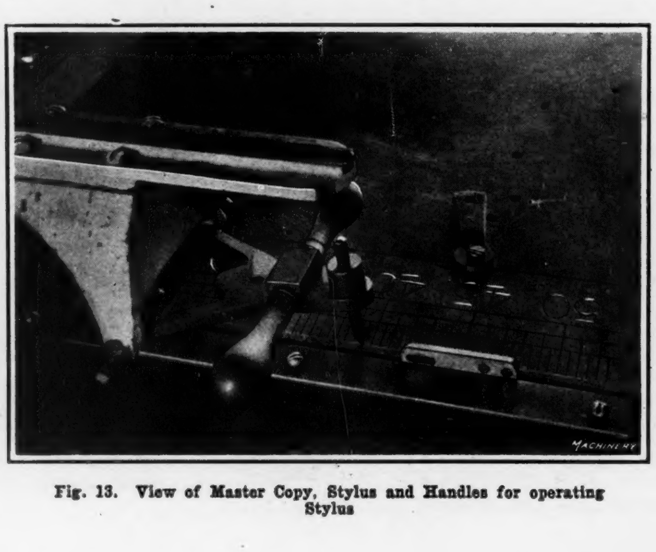

Fig. 13. View of Master Copy, Stylus and Handles for operating Stylus

design. When marking ordinary graduation lines on scales, the tracer (which is guided by the operator) is made to traverse each line on a master scale clamped to table *A*. The lateral movements of the tracer cause the main carriage *C*, which is mounted on wheels *E*, to move along the track shown, whereas the longitudinal movements shift the smaller carriage *F* along the track formed on carriage *C*. Every movement of the tracer is transmitted through the pantograph mechanism to the work-table which holds the scales or other parts to be graduated. The pantograph mechanism may be adjusted to reproduce the pattern on any scale varying, on this particular machine, from one-third to one-twentieth the size of the pattern or copy. The foot-treadle *G* is used to bring the diamonds into contact with the work. An idea of the rate of production will be gathered from the fact that in the plant of the Sawyer Tool Mfg. Co., Ashburnham, Mass., girls who operate these machines each mark 200 feet of scales per day. The master scale is made on a special machine, shown in Figs. 14 and 15, consisting principally of a precision lead-screw, a large dividing wheel for accurately spacing the division lines, and a tool for cutting these lines. The figures may be engraved on an ordinary engraving machine or they may be cut into the master by hand.

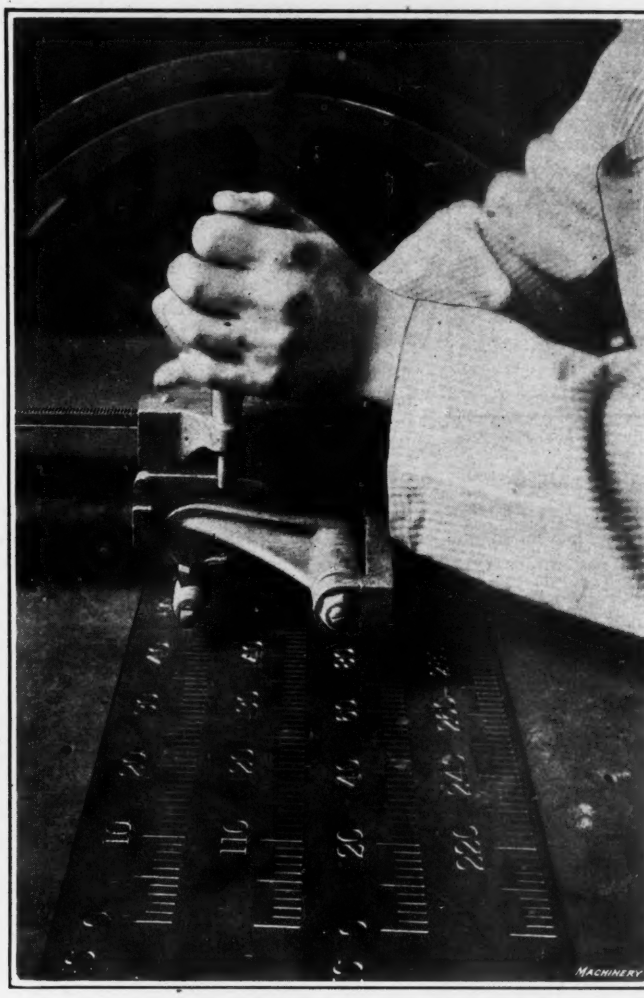

Fig. 14. Close View of Graduating Tool used on Machine shown in Fig. 15

The master scale is not always in the form of an enlarged copy of the scale to be reproduced. A special design used for graduating steel rules is shown in Fig. 16. It is 12 inches long and has four sides (see end view), on which are the different graduations required. This cross-shaped master is mounted in bearings so that any side may be turned to the upper or operating position, thus locating the face of that particular side just a little above the graduating machine table. The tracer of the machine is not pointed, but is chisel shaped, to correspond with the V-shaped grooves in the master. The length of the various division lines is regulated by a fixed plate or gage above the master, which has slots that limit the movement of the tracer. The space between the grooves on the master is much wider than on the graduated scales, the necessary reduction being obtained by the pantograph mechanism. The master is twelve inches long, but it is provided only with the graduations corresponding to a length of one inch on the scale. After marking the graduation lines for a length of one inch, the diamonds on the graduating machine are set in alignment for graduating the next successive inch division. This master is used on a machine of the type shown in Figs. 9 and 10, forty-eight steel rules being graduated simultaneously. These rules have one-half inch of excess metal at each end, which is cut off after graduating. This excess length enables the rules to be held readily. The marking of the figures into the resist involves a separate operation.

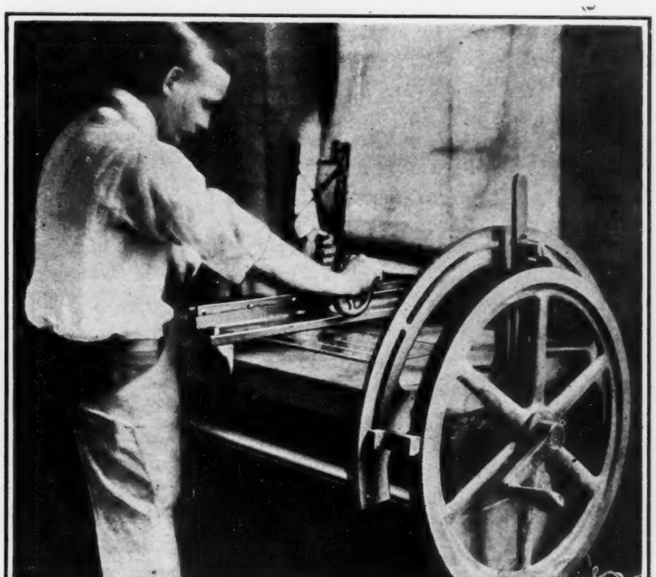

Fig. 15. Method of making Master Scales on Special Graduating Machine

Increasing Visibility of Graduation Lines

In order to secure a greater contrast between the graduation lines and the background, the lines are sometimes filled with a pigment such as black sealing wax or white lead, depending upon whether the background is light or dark. In some cases the lines are filled with block tin, which is melted into them. The surface is then polished so that the lines or figures are in clear contrast with the background. A mixture of paraffin and lampblack is also used on light work. One method of treating graduation lines which have been cut into black vulcanized rubber, by means of a machine of the Gorton type having a rapidly revolving cutter, is as follows: The lines formed by the engraving machine are filled with a paste composed of zinc oxide mixed with enough paraffin to give it a plastic consistency. A small amount of this paste is rubbed over the graduation marks and the surplus is wiped off with a cloth. This paste is very hard and durable when dry, and the white lines on the black rubber background are readily seen.

Graduating by Impression Method

When large numbers of duplicate parts require to be graduated and extreme accuracy is not necessary, the lines are sometimes formed by the use of steel stamps for flat work, or rolls for circular parts. The stamp or roll, as the case may be, has the lines and figures formed on it and is hardened so that, when the graduating tool is pressed against the work, the lines are reproduced. Fig. 18 shows a special tool for graduating index collars such as are used on the feed-screws of machine tools. The tapering arbor *A* is fitted into the lathe spindle and holds the part to be graduated at its outer end. A gear forming part of this arbor meshes with gear *B*, which is keyed to stud *C*. This stud is mounted in a holder *D* that is fastened in the toolpost of the lathe. The graduating roll is keyed to the stud *C* and is forced against the work so that the graduation lines and figures on it are reproduced on the index collar as the two revolve together. The geared drive is preferable to a friction drive between the graduating roll and work-arbor, because it is positive and prevents any shifting of the work relative to the graduating roll.

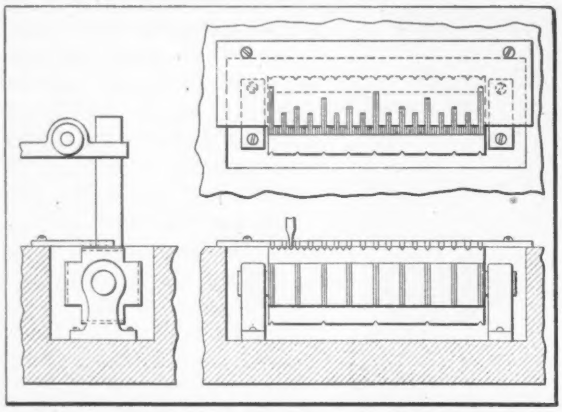

Fig. 16. Type of Master Copy used for graduating Scales on Hope Machine

Machine for Graduating Dials for Lathes

In building Conradson engine lathes, the Phoenix Mfg. Co. of Eau Claire, Wis., uses a special bench machine shown in Fig. 17 for graduating micrometer dials. It will be seen that this machine is of the type in which impressions are made by a hardened roller *A*, which is forced into work *B* without removing any metal. This is a hand-operated machine, which is actuated by turning handwheel *C* mounted at the end of a cross-shaft, on the opposite end of which there is a pinion that meshes with gear *D*. In graduating dials, it is necessary to make lines of different lengths; for instance, it may be required to cut four lines of the same length and then a fifth line of greater length. Movement of the slide that carries hardened steel roller *A* is obtained by means of a multiple-lobed cam located inside the rim of gear *D*, which engages with a roller mounted at the lower end of lever *E*. This lever has its fulcrum at *F*, and makes connection with the slide by means of a pin extending into slot *G*, the roller that engages the multiple cam being located at the opposite side of fulcrum *F* from the pin that extends into slot *G*.

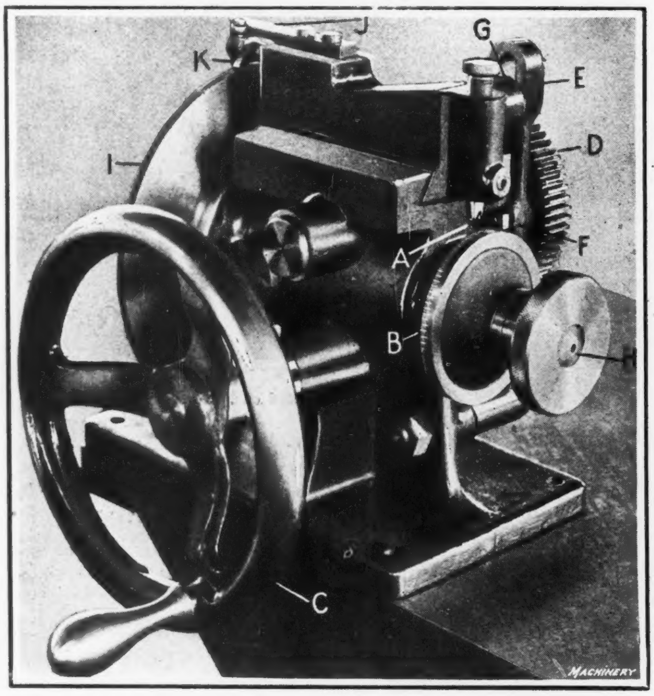

Fig. 17. Special Machine designed for rolling Graduation Marks into Feed Collars used on Conradson Engine Lathes

As gear *D* revolves, the roller at the lower end of lever *E* rides over successive lobes on the cam inside the rim of gear *D*, and as each lobe is passed the upper end of lever *E* is rocked forward, which results in feeding the hardened steel graduating roller *A* over the surface of work *B*. The length of stroke of roller *A* is regulated by the height of the different cam lobes, which provides for marking lines of the desired lengths. It will be seen that work *B* is carried on a horizontal mandrel *H*, and for indexing the work, there is a ratchet wheel *I* at the rear end of mandrel *H*, which has the same number of teeth as there are graduations to be cut in the complete circle on the work. To provide for automatic indexing, a cam *J* is secured to the back of the slide that carries marking roller *A*, and this cam engages with a roller mounted on the pivoted bracket that supports pawl *K*. During each return stroke of the ram, cam *J* moves pawl *K* forward, thereby advancing ratchet wheel *I* through one tooth space which corresponds to one division on the work. Then, as the ram moves forward to cut the next graduation mark, cam *J* allows a spring to draw pawl *K* back so that it drops into engagement with the next tooth on ratchet wheel *I*. It will be of interest to note that feed dials have been completely graduated in this way in a little less than two minutes.

A fixture for graduating the sleeves of drilling machines is shown in Fig. 19. The casting *A* of this fixture is machined to fit the drill press sleeve, as shown. The latter has a spline in it in which the block *B* is held by screw *C* for retaining the sleeve in the correct position. The hardened steel stamp *D* (see also enlarged view at *F*) is made to graduate the sleeve for a length of one inch, the graduations being to sixteenths of an inch. This stamp *D* is held in a slot in the fixture by means of a cap *G*. When a sleeve is to be graduated, it is placed in the fixture with one end against the the stop *H*. The stamp is then given a blow with a hammer, after which the spring plunger *I* is withdrawn, thus allowing rod *J* and stop *H* to be shifted to the next successive hole, which locates the stamp for graduating the next inch division. This operation of shifting the sleeve and the stop is repeated until the sleeve has been graduated to the required length.

Graduating with Milling Machine

A milling machine equipped with a spiral head is sometimes used for graduating verniers, flat scales, and other parts requiring odd fractional divisions or graduations. The spiral-head spindle should be geared to the table feed-screw so that a longitudinal movement of the table is secured by turning the indexing crank. When using a Brown & Sharpe machine, the gear for the spiral head is mounted on the differential index center inserted in the main spiral-head spindle. By varying the indexing movement, graduations can be spaced with considerable accuracy. The graduation lines are cut by a sharp-pointed tool held either in a fly cutter arbor mounted in the spindle, or between the collars of a regular milling cutter arbor. The lines are drawn by feeding the table laterally by hand, and the lengths of the lines representing different divisions and subdivisions can be varied by noting the graduations on the cross-feed screw. The gearing between the spiral-head spindle and feed-screw should be equal or of such a ratio that the feed-screw and spindle rotate at the same speed. Assuming that the lead of the feed-screw thread is 0.25 inch and that 40 turns are required for one revolution of the spiral-head spindle; then one turn of the index-crank will cause the table to move longitudinally a distance equal to one-fortieth of 0.25, or 0.00625 inch. ($1/40 \times 25/100 = 0.00625$.) Suppose graduation lines 0.03125 or 1/32 inch apart were required on a scale. Then the number of turns of the index-crank for moving the table 0.03125 inch equals $0.03125 \div 0.00625 = 5$ turns. If the divisions on a vernier reading to thousandths of an inch were to be 0.024 inch apart, the indexing movement would equal $0.024 \div 0.00625 = 3.84$ turns. This fractional movement of 0.84 turn can be obtained

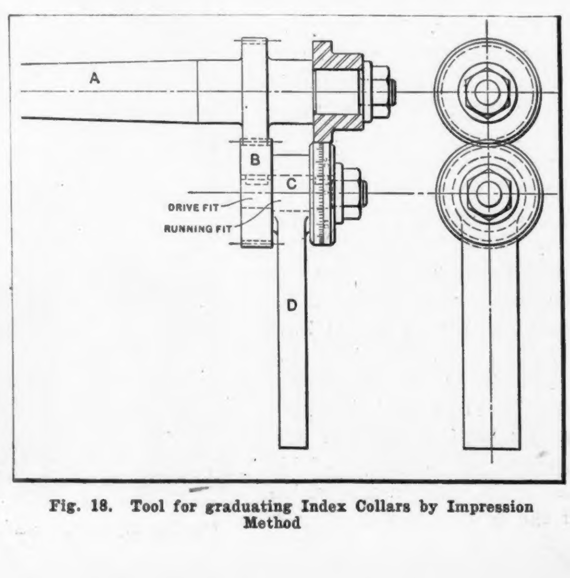

Fig. 18. Tool for graduating Index Collars by Impression Method

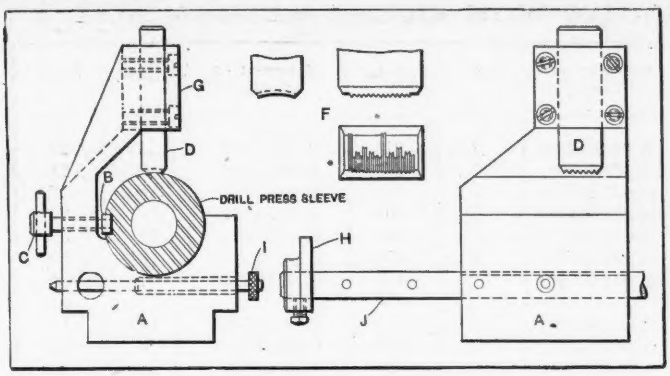

Fig. 19. Fixture for graduating Drill Press Sleeves with a Stamp

within very close limits by indexing 26 holes in the 31-hole circle; thus, three complete turns will move the work 0.00625 × 3 = 0.01875 inch, and 26/31 turn will give a longitudinal movement equal to 0.00524 +; therefore, a movement of 3 26/31 turns = 0.01875 + 0.00524 = 0.02399 inch, which is 0.00001 inch less than the required amount.

The accompanying table "Indexing Movements for Graduating with Milling Machine" was compiled by the Brown & Sharpe Mfg. Co., and will be found convenient for determining what circle to use and the number of holes to index for given dimensions. The whole number of turns required is first determined and then the indexing movement for the remaining distance is taken from the table. Thus, for graduation lines 0.0218 inch apart, three complete turns give a movement of 0.00625 × 3 = 0.01875 inch. 0.0218 — 0.01875 = 0.00305 inch. By referring to the table, it will be seen that a movement of 21 holes in the 43-hole circle equals 0.00305 +. Therefore, to index the work 0.0218 inch, the crank should be given 3 21/43 turns. In graduating in this way, the index-crank should always be turned in one direction after beginning the graduating operation, in order to prevent errors being made in the work due to any play or backlash that might exist between the table feed-screw and nut.

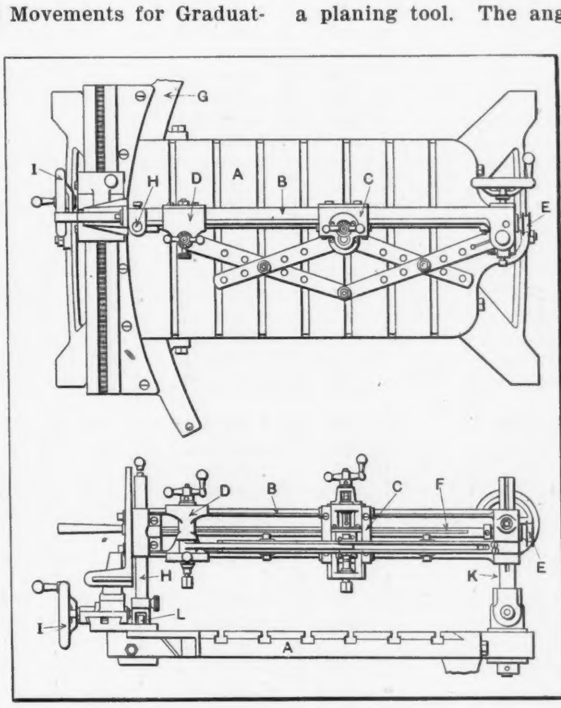

Fig. 20. Engraving and Die-sinking Machine of Pantograph Type

Graduating Tool for Fine Lines

The special form of tool shown in Fig. 21 has been used successfully for cutting fine lines of uniform depth when graduating with the milling machine. This tool is held on a regular cutter-arbor by means of the collar *A*, and, when graduating, the spindle of the machine is locked to prevent any rotary movement. The lines are cut by a sharp-pointed tool *D* made of drill rod. This tool is held in block *C* by screw *E*, the block being split as shown. The lower part of block *C* is provided with a shoe *F* which may be adjusted by screws *G* and *H*. This shoe rests upon the surface of the part to be graduated and regulates the depth of the graduation lines. When using this tool, the work-table is adjusted vertically so that the tool is sprung upward slightly or until the flat spring *B* gives sufficient pressure to overcome the resistance of the cut. As the tool is always in contact with the work, the lines are cut to a uniform depth, even though the surface being graduated is not perfectly flat. This tool was designed for graduating the scales on chronographs. The work was held in a lengthwise position on the table and the lateral movements for controlling the length of the different graduation lines were regulated by inserting small parallel strips of different thicknesses between stops on the cross-slide, which were set for the length of the longest line.

Engraving Machines

It is generally understood that graduating machines are used for cutting the division lines on various forms of scales, and that engraving machines are used for cutting letters, figures and designs in the work. These two classes of machines are naturally associated with each other, because there are a number of graduating machines on which no provision is made for cutting figures to indicate the value of scale graduations or the manufacturer's name, trademark, etc. As a matter of fact, the distinction between these two types of machines is rather fine, because many engraving machines can be used for graduating when suitable provision is made for handling this class of work. Further discussion of this subject will appear in a subsequent part of this article.

Engraving machines are designed to reproduce the form of a pattern or model on the part to be engraved, by means of a mechanism which transmits the movement of a tracing point to a suitable cutting tool. In the operation of the machine, the tracing point is made to follow the pattern or model, usually by guiding it with the hand. There are two general types of engraving machines. On one type the tool does not revolve, but is drawn across the work so that it operates the same as a planing tool. The angular position of the graver or tool may be varied to secure different effects, and the tool-holder may also be turned on some machines so that the graver will be kept facing the changing direction of the cut, but the tool does not revolve continuously.

Engraving machines may be further classified according to the form of mechanism utilized for reproducing the pattern or model on the engraved part. Many of the types intended more particularly for engraving letters or ornate designs on nameplates, dies, silverware, etc., have a pantograph mechanism for reproducing the pattern or model on a reduced scale. Other machines of the reducing type, or those using a model that is considerably larger than the design or form to be engraved, are so arranged that the necessary reduction between the movement of the tracing point which bears against the pattern and the tool or cutter is obtained by simply attaching the tracer and cutter-head to a lever at distances from the pivot of the lever proportional to the reduction required between the pattern and engraved part. Another type of engraving machine does not have a reducing mechanism, but the tracing point bears against a model corresponding in size to the impression to be engraved, and this tracing point guides the cutting tool by a direct connection with the cutter-spindle or the member in which it is mounted.

Engraving Machine of Pantograph Type

While many engraving machines have the same type of mechanism for causing the cutter to reproduce the movement

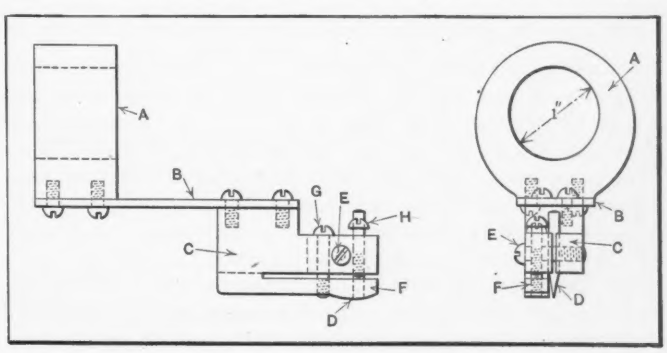

Fig. 21. Graduating Tool for cutting Fine Lines of Uniform Depth

INDEXING MOVEMENTS FOR GRADUATING WITH MILLING MACHINE

Movement of Table	Holes	Circle	Movement of Table	Holes	Circle	Movement of Table	Holes	Circle	Movement of Table	Holes	Circle
0.0001275	1	49	0.0008621	4	29	0.0016128	8	31	0.0023706	11	29
0.0001330	1	47	0.0008721	6	43	0.0016204	7	27	0.0023809	8	21
0.0001454	1	43	0.0008929	7	49	0.0016303	6	23	0.0023937	18	47
0.0001524	1	41	0.0008929	3	21	0.0016447	5	19	0.0024038	15	39
0.0001603	1	39	0.0009146	6	41	0.0016581	13	49	0.0024192	12	31
0.0001689	1	37	0.0009259	4	27	0.0016666	4	15	0.0024235	19	49
0.0001894	1	33	0.0009308	7	47	0.0016768	11	41	0.0024306	7	18
0.0002016	1	31	0.0009375	3	20	0.0016892	10	37	0.0024390	16	41
0.0002155	1	29	0.0009469	5	33	0.0017045	9	33	0.0024455	9	23
0.0002315	1	27	0.0009616	6	39	0.0017241	8	29	0.0024622	13	33
0.0002551	2	49	0.0009869	3	19	0.0017288	13	47	0.0024710	17	43
0.0002660	2	47	0.0010081	5	31	0.0017361	5	18	0.0025000	8	20
0.0002717	1	23	0.0010136	6	37	0.0017442	12	43	0.0025000	6	15
0.0002907	2	43	0.0010174	7	43	0.0017628	11	39	0.0025266	19	47
0.0002976	1	21	0.0010204	8	49	0.0017857	6	21	0.0025339	15	37
0.0003049	2	41	0.0010417	3	18	0.0017857	14	49	0.0025463	11	27
0.0003125	1	20	0.0010638	8	47	0.0018144	9	31	0.0025510	20	49
0.0003205	2	39	0.0010671	7	41	0.0018292	12	41	0.0025640	16	39
0.0003289	1	19	0.0010776	5	29	0.0018382	5	17	0.0025736	7	17
0.0003378	2	37	0.0010869	4	23	0.0018518	8	27	0.0025862	12	29
0.0003472	1	18	0.0011029	3	17	0.0018581	11	37	0.0025915	17	41
0.0003676	1	17	0.0011218	7	39	0.0018617	14	47	0.0026164	18	43
0.0003788	2	33	0.0011363	6	33	0.0018750	6	20	0.0026209	13	31
0.0003826	3	49	0.0011479	9	49	0.0018896	13	43	0.0026316	8	19
0.0003906	1	16	0.0011574	5	27	0.0018939	10	33	0.0026515	14	33
0.0003989	3	47	0.0011628	8	43	0.0019021	7	23	0.0026596	20	47
0.0004032	2	31	0.0011718	3	16	0.0019132	15	49	0.0026785	9	21
0.0004167	1	15	0.0011824	7	37	0.0019231	12	39	0.0026785	21	49
0.0004310	2	29	0.0011905	4	21	0.0019396	9	29	0.0027028	16	37
0.0004361	3	43	0.0011968	9	47	0.0019532	5	16	0.0027174	10	23
0.0004573	3	41	0.0012096	6	31	0.0019737	6	19	0.0027243	17	39
0.0004630	2	27	0.0012195	8	41	0.0019818	13	41	0.0027344	7	16
0.0004808	3	39	0.0012500	4	20	0.0019947	15	47	0.0027440	18	41
0.0005068	3	37	0.0012500	3	15	0.0020161	10	31	0.0027618	19	43
0.0005102	4	49	0.0012755	10	49	0.0020271	12	37	0.0027777	8	18
0.0005319	4	47	0.0012820	8	39	0.0020350	14	43	0.0027777	12	27
0.0005435	2	23	0.0012930	6	29	0.0020485	16	49	0.0027925	21	47
0.0005682	3	33	0.0013081	9	43	0.0020833	13	39	0.0028017	13	29
0.0005814	4	43	0.0013158	4	19	0.0020833	5	15	0.0028060	22	49
0.0005952	2	21	0.0013257	7	33	0.0020833	11	33	0.0028125	9	20
0.0006048	3	31	0.0013298	10	47	0.0020833	9	27	0.0028225	14	31
0.0006098	4	41	0.0013513	8	37	0.0020833	7	21	0.0028409	15	33
0.0006250	2	20	0.0013587	5	23	0.0020833	6	18	0.0028717	17	37
0.0006377	5	49	0.0013722	9	41	0.0021277	16	47	0.0028846	18	39
0.0006410	4	39	0.0013888	6	27	0.0021342	14	41	0.0028963	19	41
0.0006465	3	29	0.0013888	4	18	0.0021552	10	29	0.0029070	20	43
0.0006579	2	19	0.0014031	11	49	0.0021682	17	49	0.0029167	7	15
0.0006649	5	47	0.0014113	7	31	0.0021738	8	23	0.0029256	22	47
0.0006757	4	37	0.0014422	9	39	0.0021802	15	43	0.0029337	23	49
0.0006944	3	27	0.0014535	10	43	0.0021875	7	20	0.0029412	8	17
0.0006944	2	18	0.0014628	11	47	0.0021960	13	37	0.0029605	9	19
0.0007268	5	43	0.0014706	4	17	0.0022059	6	17	0.0029762	10	21
0.0007353	2	17	0.0014881	5	21	0.0022176	11	31	0.0029890	11	23
0.0007576	4	33	0.0015086	7	29	0.0022436	14	39	0.0030094	13	27
0.0007622	5	41	0.0015152	8	33	0.0022607	17	47	0.0030172	14	29
0.0007653	6	49	0.0015202	9	37	0.0022728	12	33	0.0030241	15	31
0.0007813	2	16	0.0015244	10	41	0.0022866	15	41	0.0030303	16	33
0.0007979	6	47	0.0015306	12	49	0.0022959	18	49	0.0030406	18	37
0.0008012	5	39	0.0015625	5	20	0.0023027	7	19	0.0030448	19	39
0.0008064	4	31	0.0015625	4	16	0.0023148	10	27	0.0030488	20	41
0.0008152	3	23	0.0015957	12	47	0.0023257	16	43	0.0030524	21	43
0.0008333	2	15	0.0015989	11	43	0.0023438	6	16	0.0030586	23	47
0.0008446	5	37	0.0016026	10	39	0.0023649	14	37	0.0030611	24	49

Machinery

of the tracing point on a smaller scale, the general design of different machines varies considerably. A machine built by an English manufacturer (Thomas Auty & Co.) is illustrated in part by the front elevation and plan view, Fig. 20. This type of machine is used for a variety of die-cutting work, as well as for general engraving operations. The desired form is reproduced from an enlarged former or model, by means of a pantograph mechanism, shown more clearly in the plan view. The part to be engraved is clamped to table *A* under the head *C*. The head carries a milling cutter which moves in the same direction as the tracing pin in head *D*, only on a reduced scale, the reduction depending upon the adjustment of the pantograph mechanism. The arm *B* which extends across the work-table is pivoted so that it can be traversed in a horizontal plane around the axis of the vertical stud *K*. This horizontal arm *B* is supported at its outer end by a roller *L* on the end of rod *H*, the roller traveling along the circular path *G* of the machine table. The horizontal movement of arm *B* may be effected either directly by hand or mechanically through a rack and pinion by turning handwheel *I*. The stud *K*, upon which arm *B* is pivoted, is connected to the table by a joint which permits the arm to rise and fall in a vertical plane, so as to accommodate itself to any irregular surfaces on the work. By traversing the tracing head *D* longitudinally along the arm,

INDEXING MOVEMENTS FOR GRADUATING WITH MILLING MACHINE—*Continued*

Movement of Table	Holes	Circle	Movement of Table	Holes	Circle	Movement of Table	Holes	Circle	Movement of Table	Holes	Circle
0.0031250	9	18	0.0038564	29	47	0.0046194	17	23	0.0053572	18	21
0.0031250	10	20	0.0038692	13	21	0.0046296	20	27	0.0053781	37	43
0.0031250	8	16	0.0038794	18	29	0.0046371	23	31	0.0053880	25	29
0.0031889	25	49	0.0038853	23	37	0.0046473	29	39	0.0054057	32	37
0.0031915	24	47	0.0039063	10	16	0.0046512	32	43	0.0054170	13	15
0.0031978	22	43	0.0039246	27	43	0.0046543	35	47	0.0054348	20	23
0.0032014	21	41	0.0039352	17	27	0.0046875	15	20	0.0054434	27	31
0.0032050	20	39	0.0039475	12	19	0.0046875	12	16	0.0054486	34	39
0.0032095	19	37	0.0039540	31	49	0.0047195	37	49	0.0054522	41	47
0.0032197	17	33	0.0039636	26	41	0.0047256	31	41	0.0054690	14	16
0.0032257	16	31	0.0039773	21	33	0.0047299	28	37	0.0054848	43	49
0.0032327	15	29	0.0039894	30	47	0.0047349	25	33	0.0054878	36	41
0.0032408	14	27	0.0040064	25	39	0.0047414	22	29	0.0054924	29	33
0.0032607	12	23	0.0040322	20	31	0.0047620	16	21	0.0055148	15	17
0.0032738	11	21	0.0040443	11	17	0.0047796	13	17	0.0055238	38	43
0.0032895	10	19	0.0040541	24	37	0.0047873	36	47	0.0055555	24	27
0.0033088	9	17	0.0040625	13	20	0.0047968	33	43	0.0055555	16	18
0.0033164	26	49	0.0040700	28	43	0.0048074	30	39	0.0055746	33	37
0.0033245	25	47	0.0040759	15	23	0.0048384	24	31	0.0055852	42	47
0.0033333	8	15	0.0040817	32	49	0.0048470	38	49	0.0055925	17	19
0.0033431	23	43	0.0040948	19	29	0.0048613	14	18	0.0056035	26	29
0.0033538	22	41	0.0041160	27	41	0.0048613	21	27	0.0056088	35	39
0.0033654	21	39	0.0041223	31	47	0.0048782	32	41	0.0056123	44	49
0.0033784	20	37	0.0041666	22	33	0.0048912	18	23	0.0056250	18	20
0.0034091	18	33	0.0041666	14	21	0.0048989	29	37	0.0056403	37	41
0.0034273	17	31	0.0041666	18	27	0.0049202	37	47	0.0056450	28	31
0.0034375	11	20	0.0041666	12	18	0.0049244	26	33	0.0056546	19	21
0.0034439	27	49	0.0041666	10	15	0.0049345	15	19	0.0056690	39	43
0.0034482	16	29	0.0041666	26	39	0.0049420	34	43	0.0056816	30	33
0.0034574	26	47	0.0042091	33	49	0.0049569	23	29	0.0057065	21	23
0.0034722	10	18	0.0042152	29	43	0.0049677	31	39	0.0057180	43	47
0.0034722	15	27	0.0042232	25	37	0.0049745	39	49	0.0057400	45	49
0.0034885	24	43	0.0042338	21	31	0.0050000	16	20	0.0057433	34	37
0.0035063	23	41	0.0042553	32	47	0.0050000	12	15	0.0057692	36	39
0.0035156	9	16	0.0042685	28	41	0.0050308	33	41	0.0057874	25	27
0.0035255	22	39	0.0042765	13	19	0.0050402	25	31	0.0057927	38	41
0.0035325	13	23	0.0042971	11	16	0.0050532	38	47	0.0058142	40	43
0.0035474	21	37	0.0043104	20	29	0.0050596	17	21	0.0058187	27	29
0.0035714	12	21	0.0043268	27	39	0.0050676	30	37	0.0058336	14	15
0.0035714	28	49	0.0043368	34	49	0.0050785	13	16	0.0058466	29	31
0.0035904	27	47	0.0043477	16	23	0.0050876	35	43	0.0058512	44	47
0.0035984	19	33	0.0043562	23	33	0.0050928	22	27	0.0058599	15	16
0.0036186	11	19	0.0043605	30	43	0.0051022	40	49	0.0058674	46	49
0.0036289	18	31	0.0043750	14	20	0.0051136	27	33	0.0058710	31	33
0.0036339	25	43	0.0043883	33	47	0.0051281	32	39	0.0058825	16	17
0.0036585	24	41	0.0043922	26	37	0.0051474	14	17	0.0059027	17	18
0.0036637	17	29	0.0043980	19	27	0.0051627	19	23	0.0059122	35	37
0.0036765	10	17	0.0044119	12	17	0.0051721	24	29	0.0059215	18	19
0.0036858	23	39	0.0044210	29	41	0.0051830	34	41	0.0059294	37	39
0.0036990	29	49	0.0044354	22	31	0.0051861	39	47	0.0059375	19	20
0.0037038	16	27	0.0044643	15	21	0.0052083	15	18	0.0059455	39	41
0.0037163	22	37	0.0044643	35	49	0.0052296	41	49	0.0059524	20	21
0.0037234	28	47	0.0044871	28	39	0.0052327	36	43	0.0059598	41	43
0.0037500	12	20	0.0045060	31	43	0.0052365	31	37	0.0059782	22	23
0.0037500	9	15	0.0045140	13	18	0.0052419	26	31	0.0059841	45	47
0.0037793	26	43	0.0045213	34	47	0.0052635	16	19	0.0059951	47	49
0.0037878	20	33	0.0045259	21	29	0.0052884	33	39	0.0060188	26	27
0.0038043	14	23	0.0045452	24	33	0.0053030	28	33	0.0060346	28	29
0.0038112	25	41	0.0045610	27	37	0.0053125	17	20	0.0060480	30	31
0.0038195	11	18	0.0045732	30	41	0.0053194	40	47	0.0060607	32	33
0.0038265	30	49	0.0045835	11	15	0.0053242	23	27	0.0060812	36	37
0.0038305	19	31	0.0045920	36	49	0.0053364	35	41	0.0060898	38	39
0.0038460	24	39	0.0046055	14	19	0.0053572	42	49	0.0060980	40	41

Machinery

the tracing pin is moved in or out as the arm swings horizontally, in order to follow the outline of the former or pattern. Any movement that is given to the tracing head *D* is reproduced by the cutter-head *C* on a reduced scale. The cutter-spindle is driven by a shaft *F* which carries a belt pulley *E*. Motion is transmitted from the shaft *F* to the cutter-spindle, through helical gearing in the cutter-slide. The arm *B* is secured to stud *K* by means of a set-screw, and the height of the arm may be varied according to the height of the work being operated upon. There is a spring-support on the end of rod *H*, which takes the weight of the arm when vertical movements are required. A thumb-screw is provided for preventing the spring from acting when vertical movements are not required.

Engraving Machine Having Graduated Pantograph

Another engraving machine which operates on the pantograph principle, but differs in design from the one previously described, is shown in Fig. 22, which illustrates the pantograph mechanism and the method of rotating the cutter-spindle. This machine is used for engraving nameplates, trademarks, letters, numbers, etc., on steel stamps, dies and other products. A pattern of the required design is placed in a slot in the pattern table *A*, where it is clamped in position. At

one end of the pantograph, there is a tracing or guiding point *B*, which is made to follow the pattern or letters which are to be reproduced on the work. The engraving tool *C* is carried by a spindle at the opposite end of the pantograph mechanism. Three of the arms on the pantograph are provided with scales by means of which the relation between the lengths of the arms can be adjusted to obtain any desired size of an engraved design, the limit of the machine being from a ratio of 1 to 1 between the size of the work and pattern, down to a ratio of 1 to 10. When the pattern is to be used repeatedly, it is carefully made and, in the case of letters, these are cut into the pattern plate, thus forming a positive guide for the tracing point. When only a few pieces are to be engraved, the design may be drawn on bristol board, but when such a design is used more care is required in operating the machine, because the movements of the tracing point must be controlled entirely by hand. Owing to the universal movements of the engraving tool, it is necessary to provide a flexible system for driving the cutter-spindle. The arrangement of the belt drive in this particular case is apparent from the illustration.

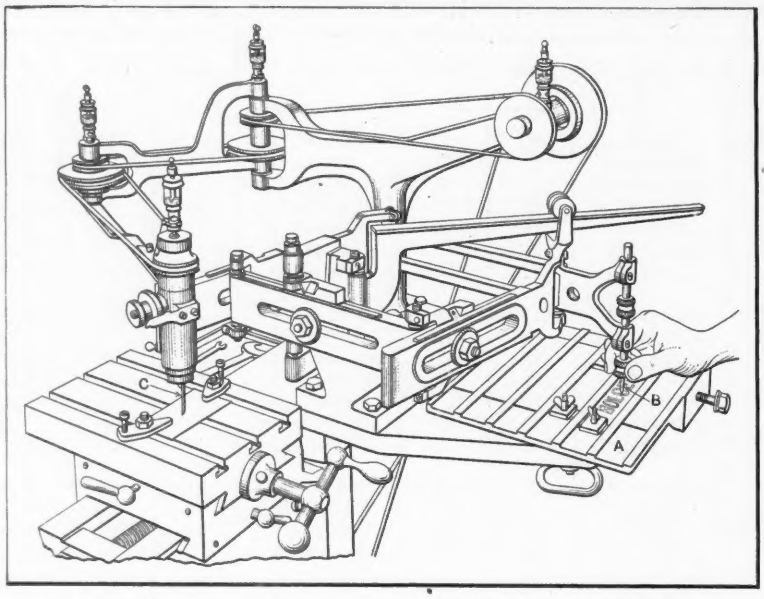

Fig. 22. Pantograph Mechanism provided with Graduated Scale Adjustment

The engraving tool used on this machine is cylindrical in shape, except at the lower end, where for about 1½ inch a flat is ground so that about one-half of the metal is removed, and a suitable cutting edge is formed on the lower end. Experience has shown that the best results are obtained by having the ground surface of the tool of an elliptical section instead of circular, and this special form is obtained by a grinding attachment used in connection with the machine. By means of this attachment, the motion of the tool is controlled when in contact with the grinding wheel, by means of a cam which forms part of the attachment.

Engraving Cylindrical or Conical Surfaces

When cylindrical or conical surfaces are to be engraved on the machine shown in Fig. 22, an attachment is used which consists principally of a work-holding device that can be tilted to any desired angle, in order to locate the surface in the proper position relative to the engraving tool. This work-holding device can also be rotated or indexed for the accurate spacing of designs to be engraved on different parts of the work. In most cases where engraving is done on cylindrical or conical surfaces, the pattern itself is flat and is clamped to the pattern table in the usual way, to transfer the marking to the work.

Engraving Concave or Convex Surfaces

Either concave or convex surfaces can be engraved on this machine by using an attachment designed for the purpose. When doing work of this kind, it is necessary to have the engraving tool cut to a uniform depth, but the tool must also follow the contour of the work. This means that the tool must be moved vertically as it is traversed in a horizontal direction, the extent of the vertical movement depending upon the curvature of the work. This movement is obtained as follows: The work, instead of being clamped directly to the work-table, is supported by a plate which is mounted upon four studs so that there is a space beneath the plate. On the bottom plate, which is attached to the lower ends of the four supporting studs, there is a master blank which conforms to the curvature on the work. A guide point, connected by a bracket with the cutter-spindle, is in contact with this master blank, so that, as the cutter-spindle is moved horizontally, it also moves vertically, thus causing the tool to cut to a uniform depth. The tracing point is guided by a flat pattern so that the engraved design is not an exact reproduction of the pattern, owing to the curvature of the surface upon which the tool operates. Unless the radius of curvature is very small, however, the error in reproduction is so slight as to be negligible. The work-table of this machine is carried by a knee which may be adjusted vertically along the face of the machine column, and it has, in addition, longitudinal and transverse adjustments.

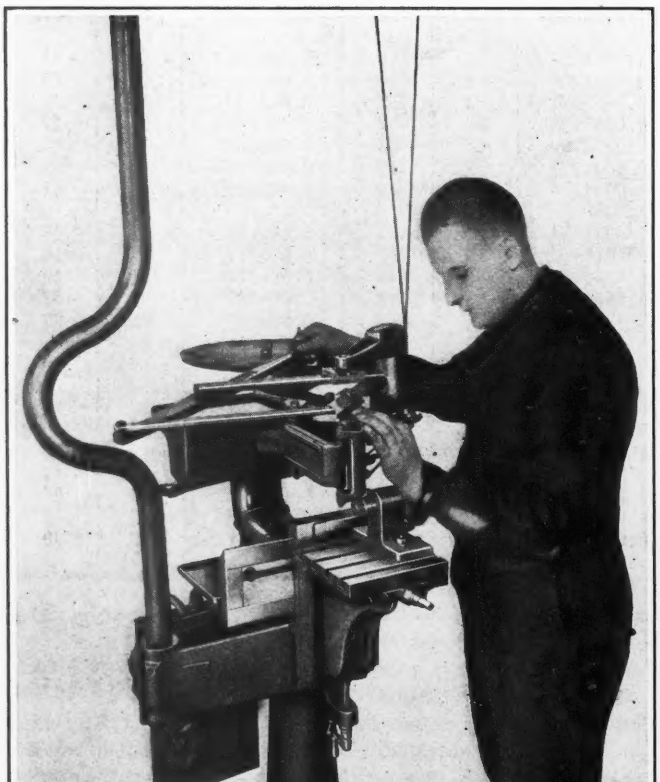

Fig. 23. Method of engraving Figures on Cylindrical Work—Illustration shows George Gorton Engraving Machine

Gorton Engraving Machine

Another design of engraving machine of the pantograph type which is built by the George Gorton Machine Co., Racine, Wis., is shown in Fig. 24. With this machine, reductions in size varying from 3 to 1 to zero may be obtained. In other words, the pantograph mechanism can be adjusted to reduce the size of any particular pattern or copy from one-third down to the point where the movement of the tracer point or stylus does not transmit any motion at all to the engraving tool. The part to be engraved is attached to table *G* which is provided with slots for receiving clamping bolts. This table is mounted upon a knee and can be adjusted vertically and horizontally. The engraving is done by cutters of different shapes which are held either in a chuck or directly in the spindle. The latter method is employed for the larger sizes having tapered shanks.

The cutter-spindle is located below the sliding block

E and is driven by a small band or belt connecting with an overhead countershaft and passing over the idler pulleys *J* to a pulley on the spindle. For engraving brass, the cutter is rotated at a speed varying from 8000 to 10,000 revolutions per minute. For soft steel, the speed is 4000 revolutions per minute and for tool steel, from 2500 to 3000 revolutions per minute. For engraving glass or on carbon brushes, a diamond tool is used. Black diamonds, like those used for truing grinding wheels, are employed for work of this kind. Cutters for ordinary work are usually made from Stubs drill rod, and after the cutters have been formed to the proper shape, they are hardened in water and drawn to a light straw color.

The construction of the spindle of the Gorton engraving machine is shown in Fig. 25. The cutter-spindle *A* is located inside a cylinder having a lower bearing *B* made of tool steel, hardened and ground. The upper end of the spindle is tapered to an angle of 60 degrees and runs in a hardened and ground conical bearing *C*, provided with an oil-hole for lubricating the spindle with fine sperm oil. The spindle carrier is held in position by conical screws *D*, which are so adjusted that the spindle frame is free to move, but without lost motion.

When the graduated collar *E* is set at zero, the cutter may be moved up or down by turning the screw *F*, and the stop-rod *G* may be set to control the depth at which the cutter operates. Instead of feeding the cutter down to a fixed stop, the graduated scale *E* may be used for feeding the cutter to any required depth, as measured from the surface of the work being engraved.

The divisions on the scale indicate hundredths of an inch. The thumbscrew *H* is released when collar *E* is to be adjusted. In order that the cutter may be raised and then lowered to the same point without difficulty, two stops *M* and *N* are provided between which the pin *O* operates. The screw *F* is turned until the cutter just touches the surface of the work, and it is then turned backward until pin *O* comes against stop *N*, which locates the cutter at the required depth.

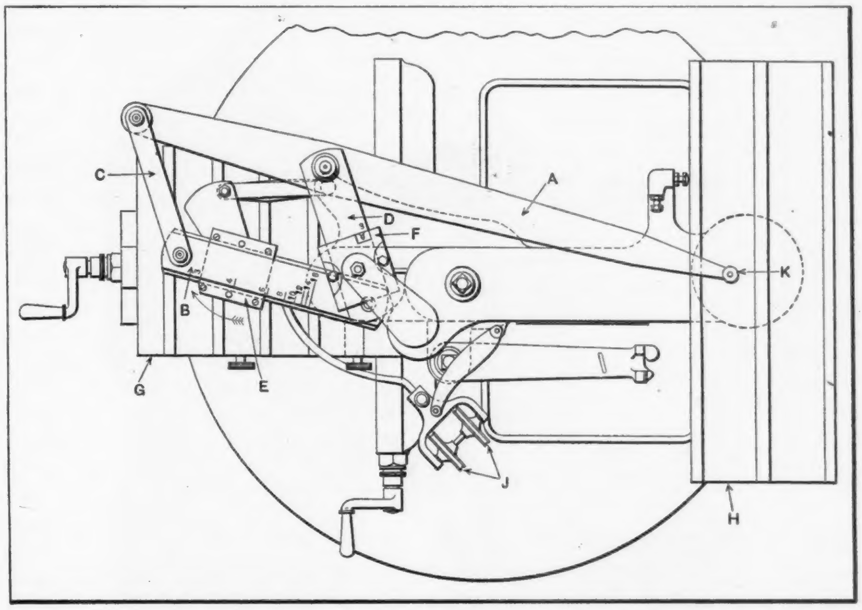

Fig. 24. Pantograph Mechanism on Gorton Engraving Machine

The pantograph mechanism, a plan view of which is shown in Fig. 24, has one long and one short arm. The main pantograph arm carries the stylus or tracer point *K* which follows the copy or model that is clamped to table *H* at the rear of the machine. This arm is connected to the long arm *B* by means of a link *C*; the short arm *D* also forms a connecting link between arm *B* and the stylus bar *A*. The relation between the movement of the stylus point at *K* and the movement of the cutter is governed by the relative positions of the sliding blocks *E* and *F* on the long and short arms *B* and *D*. To set the pantograph for a given reduction, the bolts on slides *E* and *F* are loosened and these slides are then set at whatever distances from the datum lines are required to give the necessary ratio of reduction. As previously mentioned, the least reduction is one-third and, consequently, the graduations begin at 3. A table accompanying the machine shows the various positions for blocks *E* and *F* which are necessary to obtain any reduction from 3 to 1 to 30 to 1. The movable arms are provided with ball bearings to reduce friction to a minimum.

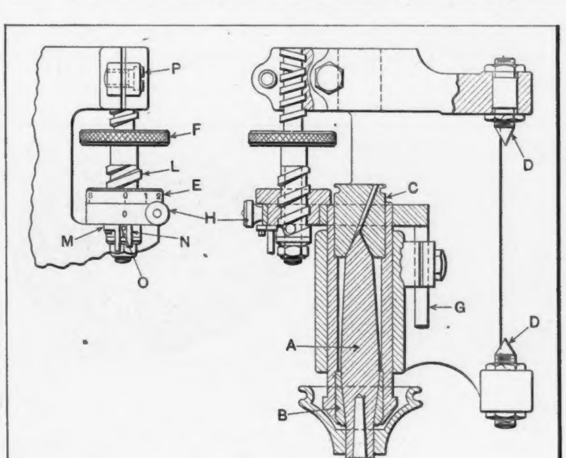

Fig. 25. Cutter-spindle Construction of Gorton Engraving Machine

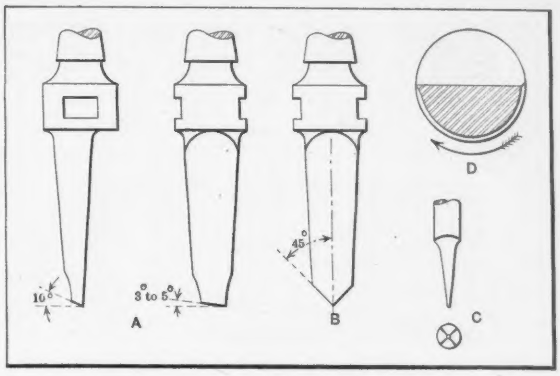

Fig. 26. Types of Cutters used for Engraving Operations

Cutters Used for Engraving

The three principal types of engraving cutters used in the machine shown by the plan view, Fig. 24, are illustrated in Fig. 26. The roughing type of cutter shown at *A* is flattened on one side and is sharpened on the point so as to penetrate the work like a drill when it is first fed down for starting a cut. It is ground with a slope of from 3 to 5 degrees, and is given a clearance of about 10 degrees. The cutter shown at *B* is used for finer work and is known as a conical pointed cutter. It is generally ground to an angle of 45 degrees and is made flat on one side, similar to the form shown at *A*. The cutter shown at *C* is used for very fine work. The cutting end is tapering and of square cross-section. This cutter is only used for operating against the side of an engraved surface and cannot be fed down into the work. Cutters of this type are only about 0.100 inch in diameter, and are held in a chuck.

The cutters should revolve in a clockwise direction as viewed from above, and the cutting edge should be backed off as shown by the enlarged section *D*. The pointed cutter shown at *B* should be sharpened carefully, to insure that the point of the cutter will be absolutely true and that the entire cutting edge will have the proper amount of clearance. When grinding the small cutter shown at *C*, it is essential that the cutting end be true with the axis, and an indexing fixture is generally employed for grinding. The cutter is tested on the machine to see that the point runs true. The edges of this cutter should also be finished with an oilstone.

Making Patterns for an Engraving Machine

The "copy" or pattern used on an engraving machine as a guide for the tracer point is made of various materials, such as zinc, celluloid,

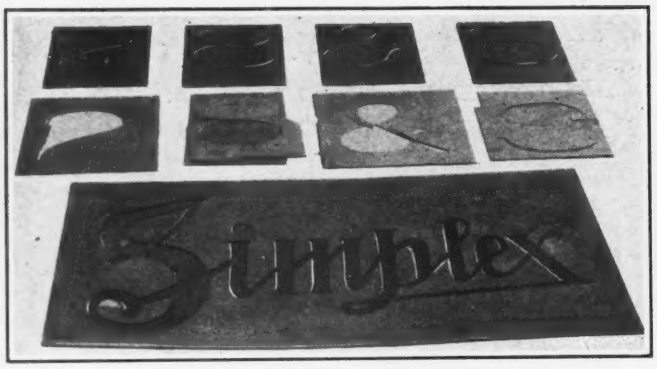

Fig. 27. Top Row, Master Copies for Permanent Use; Second Row, Sheet Metal Templets for making Master Copy; Bottom Row, Master Copy for Temporary Use, made of Cardboard and varnished

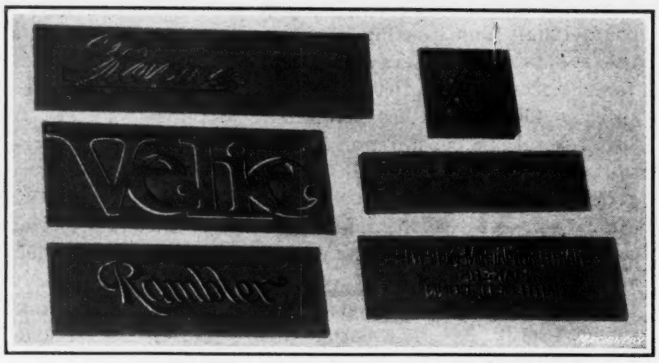

Fig. 28. Examples of Flat Work engraved on Machines manufactured by the George Gorton Machine Co., of the Type shown in Fig. 29

hard rubber, and brass. In some cases, heavy paper or bristol board is used, especially when only a few parts are to be engraved and the expense of making a more substantial pattern is not warranted. Brass is often used when a large number of duplicate parts are to be engraved. These patterns are made in different ways, the method depending somewhat upon the accuracy required and the kind of pattern needed. If the pattern is for a new or original design, one method is to first lay out the design on heavy paper to an enlarged scale. This design is then used for engraving the pattern which is attached to the regular work-table of the machine. In order to provide a more positive guide for the tracer, several thicknesses of paper, cut to the required form, may be mounted on a sheet of metal with shellac. The shellac not only holds the paper in position, but hardens the edges which serve as a guide for the pantograph tracing point when engraving the pattern. Another method of making the pattern is to engrave the required design directly upon the pattern by hand. The design is sometimes engraved by hand in a sheet of hard rubber which is either used as the regular pattern or is employed temporarily for engraving a duplicate in brass, especially when a very durable pattern is required. Still another method is to make an enlarged drawing of the design and transfer the outline to a sheet of transparent celluloid which is placed over the drawing. The celluloid is then cut out to conform to the design, thus obtaining a male and female model. This method is useful when making punches and dies of irregular shape.

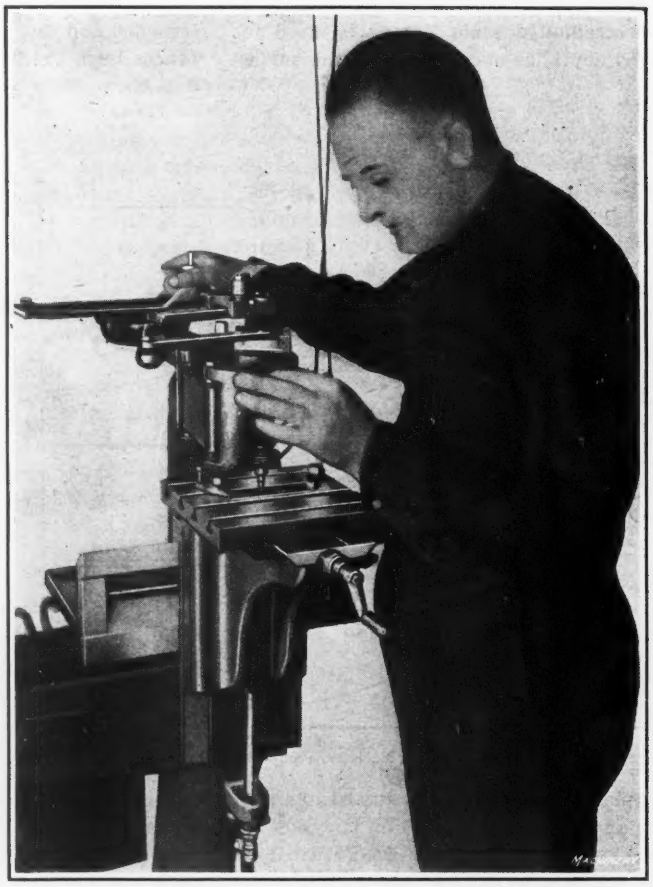

Fig. 29. Engraving Nameplate on Gorton Engraving Machine of Type shown in Fig. 24

Patterns for engraving letters are furnished in different styles and sizes by the manufacturers of engraving machines. These individual letters are arranged in a suitable holder in the desired position on the pattern or copy table, and are used as a pattern for engraving the work.

Reproducing Pattern from Sample

In many cases, manufacturers send an engraved sample which is to be duplicated. One method of making a pattern from a sample is as follows: The shape of the design is first transferred to tracing paper, either by a rubbing process or in any convenient way, and the design is then thrown upon a screen with a projecting lantern, to a scale which may be twenty times the size of the sample. The outline of the image is traced in pencil upon a sheet of manila paper, after which the tracing is tacked on a drawing-board and any slight irregularities and distortions are corrected. The sketch is then cut out and mounted on a sheet of galvanized steel by using shellac, and by applying several thicknesses of paper an edge is formed which serves as a guide for the tracer point. This temporary pattern is used to generate a more substantial one either in brass or other material, as previously explained.

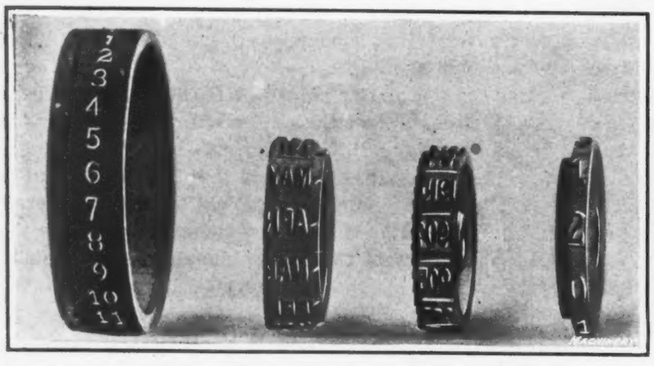

Fig. 30. Examples of Figures, Letters and Graduation Marks cut on Cylindrical Work

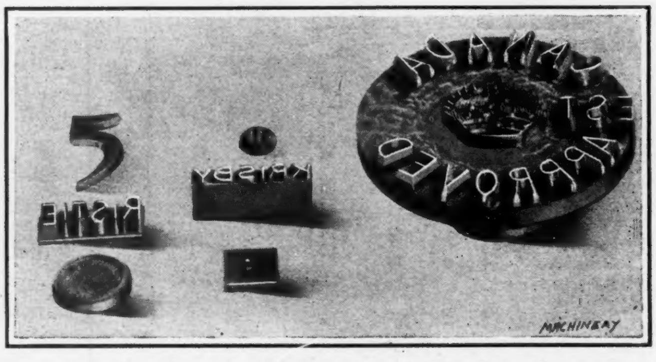

Fig. 31. Examples of Engraving where Design is in Intaglio and in Relief, Illustrating Range of Work that can be handled on Engraving Machines

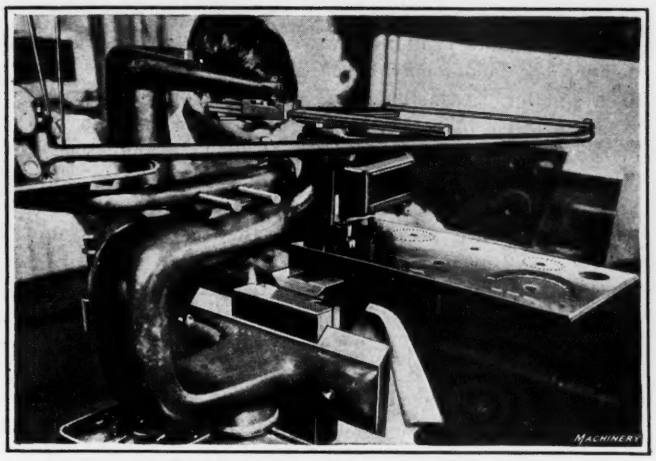

Fig. 32. Work of graduating Instrument Board of Type shown in Fig. 35

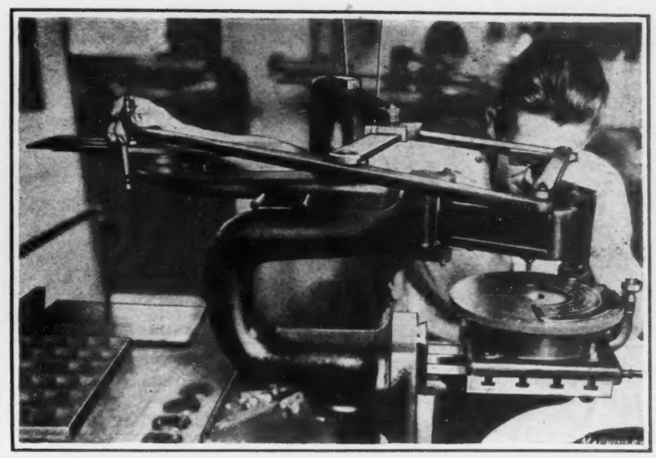

Fig. 33. Universal Indexing Fixture for graduating Standard Circular Scales

Making Masters for "Copy" on Gorton Machines

The George Gorton Machine Co., of Racine, Wis., uses the following methods for making "copy" used on engraving and graduating machines of its manufacture. In making the copy for graduating scales and similar work, the lines are laid off by means of a dividing engine in cases where a high degree of accuracy is required; but for work that does not demand so high a degree of precision, the dividing head of the milling machine or feed mechanism of the lathe may be relied upon to give sufficiently accurate results.

In cases where the Gorton machines are used for engraving, the "copy" for figures, letters or designs that are to be cut can be made by a variety of different methods, the most common of which is to cut out a templet from sheet metal or paper (if paper is used it must be varnished) and use the templet as copy for engraving a master from metal that will be used in cutting subsequent work produced on the machine. Fig. 27 shows in the top row, a set of finished masters, and in the middle row the sheet metal templets that were first cut out for use in making these masters. It will be of interest to note that it is not always necessary to make a complete templet, because in any cases where the figure, letter, or design has straight lines of considerable length, it is often possible to use the slides on the machine for rapidly cutting such lines. For instance, in the case of the templet for cutting a 2, it will be seen that the curved stroke of the figure is the only part that is produced on the templet. After the templet has been followed to cut this curved stroke, the cross-slide on the machine is brought into action and the straight base of the figure is rapidly finished. Copy for letters and numbers is ordinarily made in ¾-, 1½- and 3-inch sizes to fit the standard copy-holders provided on the machines.

An interesting principle is shown in the case of the preliminary sheet metal templet for an ampersand (&). In engraving, uniform results would not be obtained if it were necessary to interrupt the movement of the engraving tool in following the outline of a letter, and to produce a continuous movement of the tool, an ingenious arrangement of "switches" has been provided at the junction between the upper and lower sections. It will be seen that these switches can be so set that the tool follows around continuously in cutting the upper and lower sections of the symbol. In most cases, the sheet metal templets are used as copy in making masters from metal, but where there are only a few pieces to be engraved, the sheet metal or paper templet is used as the copy from which engraving is done directly on the work. An example of this kind is shown in the case of the paper templet for engraving the word "simplex."

Quite a wide range of work can be handled on the Gorton machines, as will be seen from Figs. 28, 30 and 31, which illustrate typical examples of flat work on which the engraved design is in relief and intaglio, and of rolls on which the engraving and graduating operations have been performed on a convex surface. Machines are shown in operation performing all these classes of work, and the description already given covers such operations, with the exception of engraving designs on rolls, for which a special fixture is required. Fig. 23 shows a graduating machine equipped with one of these fixtures, and it will be seen that the copy consists of a flat dial on which the required notations have been cut.

The work is secured at the end of an arbor carried by the fixture, and at the opposite end of the arbor is an index plate In operating the machine, the master plate or copy is moved around so that the desired notation is brought under the stylus and the copy is then held in this position by means of a plunger that enters one of the index notches in the periphery of the plate. The work is secured in the initial position by means of a plunger that enters one of the notches of an index plate at the rear end of the work-holding mandrel after which the engraving operation is conducted in the usual way. To provide for engraving subsequent notations on the work, both the master and work are indexed, engraving and indexing operations being performed alternately until the job has been completed.

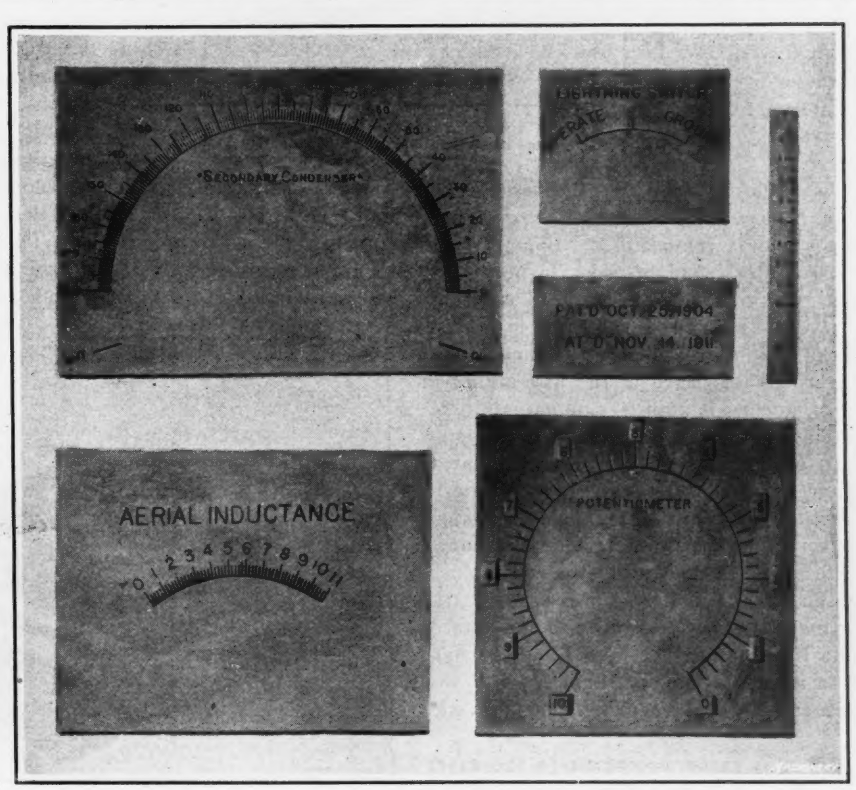

Fig. 34. Master Copies used for graduating Work of General Type shown in Fig. 35

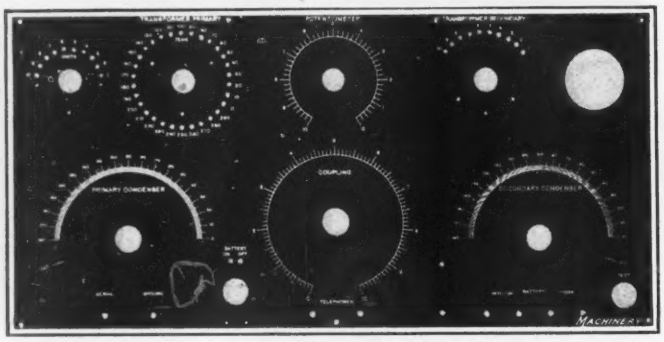

Fig. 35. Instrument Board for Marconi Wireless Telegraph Apparatus, on which all Graduating and Engraving Operations were performed on Gorton Machine

Engraving Surfaces of Varying Curvature

On at least one class of convex work, the curvature of each part to be engraved varies more or less, so that a single former for guiding the cutter vertically cannot be used. The mother-of-pearl handles used on revolvers and automatic pistols are an example of work of this kind. As each half of a pearl revolver handle is of different shape and thickness and no two are exactly alike, an individual former must be provided for every piece. A method of doing work of this kind is as follows: Separate formers of sealing wax are made in a mold for each handle, and the pearl handle to be engraved and the wax former are sent to the engraving machine together. A special fixture is used for making these wax formers, so arranged that melted wax can be poured around the handle, which forms an impression in the wax. When the mold is being made, the handle is mounted on a plate which engages grooves in the bottom of the fixture. The jig for holding the handle on the engraving machine has corresponding grooves so that the handle is properly located with reference to the wax former. The latter is attached to the machine directly over the cutter-spindle where it is fixed in a dovetailed holder. A guide point on top of the cutter-spindle casing is held in contact with the former by a spiral spring.

Graduating Scales for Marconi Wireless Telegraph Instruments

For engraving the various forms of scales used on the instruments of its manufacture, the Marconi Wireless Telegraph Co., employs machines operating on the pantograph principle in its plant at Aldene, N. J. Most of these scales are graduated on plates or dials composed of "Bakelite" (a material resembling hard rubber), and in order to make the graduations easily read, zinc oxide mixed with a sufficient quantity of paraffin to give the required consistency is rubbed into the graduation marks after they are cut on the machines. This mixture hardens through exposure to the air, giving a high degree of durability, and as it affords a combination of white graduations on a black background, the scales are easily read. Fig. 35 shows an example of one of these graduated plates, and in Figs. 32 and 33, graduating machines are shown producing work of this kind. A model is made in which graduations are cut to correspond with the required graduations on the work, and this model is set up in the copy-holder on the machine so that the tracer point can run over it. Various forms of engraving tools are used according to the nature of the work; where fine lines are to be cut the tool is generally in the form of a pointed "cannon drill," while for heavier classes of work end-mills of various forms are employed.

The size of model used also varies according to the character of the work. In cases where fine graduating is to be done on a relatively small area, it is desirable to make the model several times larger than the work, as it is more convenient to make it in that way, while in the case of simple designs the model may be of the same size as the work or even smaller. Adjustment of the pantograph linkage is provided in order to obtain any required ratio between the size of the model and the work. Fig. 34 shows examples of different models used on Gorton graduating machines at the plant of the Marconi Wireless Telegraph Co.; these are made of brass and it will be evident that they can be conveniently cut on a milling machine or circular dividing engine.

In the manufacture of wireless telegraph apparatus, there are many cases where circles have to be divided into degrees, examples of this kind being shown on scales marked "Primary Condenser" and Secondary Condenser," which will be seen at the lower left- and right-hand sides of Fig. 35. In order to avoid having to make special models for this purpose, the expedient has been adopted of producing a universal fixture which is shown in operation in Fig. 33. This fixture is secured to the work-table and has a pivoted disk with 360 equally spaced teeth cut in its periphery. On the model table there is a simple plate with graduations cut in it of the required lengths for the scale to be produced on the work. The work is strapped to the top of the pivoted plate of the fixture and indexed space after space by means of teeth in the periphery of this plate. After each setting of the work has been made, the tracer point is drawn over the graduation mark on the model, which governs the length of graduations cut on the work. This fixture can be used for graduating any scales requiring circles or parts of circles to be divided into degrees.

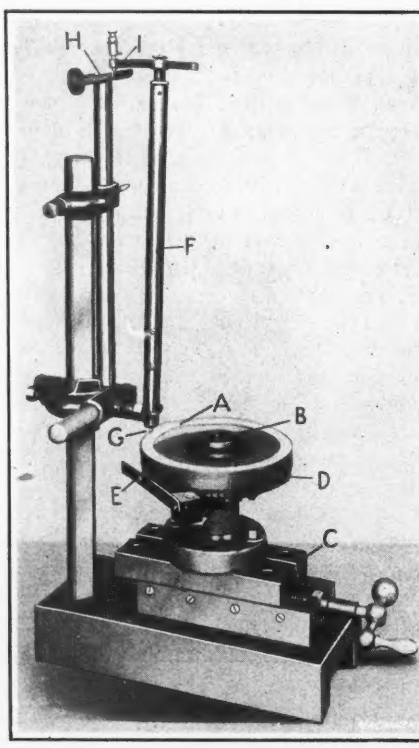

Fig. 36. Special Engraving Machine used in Instrument Shops of William Gaertner & Co. for engraving very Small Figures and Notations

Small Engraving Machine for Use on Bench

The distortion resulting from the use of hardened steel stamps for marking gages and other forms of measuring tools or delicate instruments is generally recognized among machinists and toolmakers. The engraving machine illustrated in Fig. 37 was designed for marking all sorts of fine tools that might be injured by the use of stamps. A suitable resist is applied to the surface of the hardened tool and the machine is used for tracing the letters or designs required, which are afterward cut into the surface by applying an etching fluid. The machine operates on the pantograph principle. It is equipped with metal matrices or copy blocks which can be arranged like type in any desired combination of letters or figures.

In use, the stylus is guided by these matrices and the tracing point reproduces the lettering or figures on a smaller scale. The pantograph mechanism gives a reduction of 4 to 1 so that

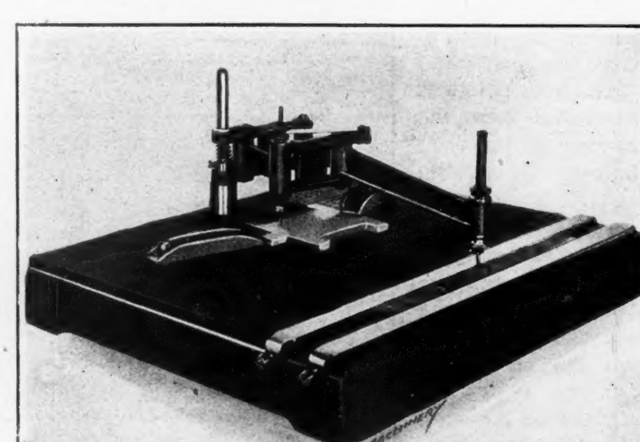

Fig. 37. Bench Type of Engraving Machine Suitable for handling General Classes of Work of Moderate Size

if ⅛-inch characters are required on the work, matrices with ½-inch face are necessary. The part to be etched is held in position on the table of the machine by the clamps shown, and the matrices are held in proper alignment by two parallel strips or bars, as the illustration shows. This machine is built by the Spicer Tabulating Machine Co., 3318 Volta Place, N. W., Washington, D. C.

In Fig. 36 is shown a machine of somewhat similar design to the one described in connection with Fig. 7. It was built by William Gaertner & Co. and is used in their instrument shop for cutting notations that are desired on different classes of work—particularly for numbering graduated scales. The operation is similar to that of the previous machine, Fig. 7, except that in this case the work *A* is held on a vertical arbor *B* supported on a slide *C*, the position of which may be regulated for engraving work of various radii. Secured to mandrel *B* is a notched index plate *D*, which is engaged by a plunger carried on spring *E*. It will be seen that the engraving tool is carried at the lower end of vertical arm *F*, which is pivoted at *G*, the ratio being such that the machine is only adapted for cutting exceedingly small letters. Master letters are secured to copy-holder *H*, and stylus *I* is run over these letters in the usual manner.

Etching and Etching Fluids

A common method of etching names or simple designs upon steel is to apply a thin, even coating of beeswax, or some similar substance that will resist acid; then mark the required lines or letters in the wax with a sharp-pointed scriber, thus exposing the steel (where the wax has been removed by the scriber point) to the action of an acid, which is finally applied. To apply a very thin coating of beeswax, place the latter in a silk cloth, warm the piece to be etched, and rub the pad over it. Regular coach varnish is also used instead of wax, as a "resist."

Etching Fluids for Steel

An etching fluid ordinarily used for carbon steel consists of nitric acid, 1 part; water, 4 parts. It may be necessary to vary the amount of water, as the exact proportion depends upon the carbon in the steel and whether it is hard or soft. The acid oxidizes the metal along the lines that have been exposed by the marking points of the graduating machine, and leaves these lines darker than the surrounding metal so that they may readily be seen. For hard steel, use nitric acid, 2 parts; acetic acid, 1 part. For high-speed steel, nickel, or brass, use nitro-hydrochloric acid (nitric, 1 part; hydrochloric, 4 parts). For high-speed steel it is sometimes better to add a little more nitric acid. For etching bronze, use nitric acid, 100 parts; hydrochloric acid, 5 parts. For brass, nitric acid, 16 parts; water, 160 parts; dissolve 6 parts of potassium chlorate in 100 parts of water; then mix the two solutions and apply.

A fluid that may be used either for producing a frosted effect or for deep etching (depending upon the time it is allowed to act) is composed of 1 ounce of sulphate of copper (blue vitriol); ¼ ounce of alum; ½ teaspoonful of salt; 1 gill of vinegar; and 20 drops of nitric acid. For aluminum, use a solution composed of alcohol, 4 ounces; acetic acid, 6 ounces; antimony chloride, 4 ounces; water, 40 ounces.

Etching Names on Tools

The National Twist Drill Co. employs the following method for etching on cutters and other tools: The steel is brushed with asphaltum varnish, which is allowed to stand until it thickens and hardens to the right degree; then the desired inscription is pressed through the asphaltum with a rubber stamp and the etching fluid (nitro-hydrochloric acid or *aqua regia*) is applied with a medicine dropper. Practice and experience are required to judge just when the varnish has dried to the right consistency.

A similar method, which has been successfully used for etching names on cutlery, is to coat the surface with gum guaiacum varnish. A rubber stamp having the name or design is then moistened with a thin layer of potash solution. When this stamp is applied to the work, the varnish is "cut" by the potash wherever the coated stamp comes into contact with it; the surface is then brushed lightly with water in order to remove the loosened varnish and expose the lettering or design, which is then etched by applying dilute nitric acid. The rubber-stamp method is a very cheap and rapid process. One method of applying the potash is to press the stamp against a pad soaked with the solution.

The action of etching fluids on steels varies somewhat according to the composition, high-carbon and alloy steels being acted upon more slowly than low-carbon steel or wrought iron. Etching fluids that work successfully on low-carbon steel may not work well on high-carbon steel or cast iron. The usual difficulty is that the carbon liberated by the etching fluid settles to the bottom and prevents further action. This difficulty can be overcome, however, by frequently renewing the acid and cleaning out the carbon deposit so that the fresh acid will come into direct contact with the metal.

Etching Brass

The first step in etching is to see that the parts that are to be etched are carefully ground and polished. The only cleaning that will be found necessary can be satisfactorily done by wiping the work with a dry rag. One method of etching brass is as follows: First heat the work and then dip it into molten paraffin, after which it should be removed and allowed to stand until cool. The pattern that is to be etched is marked in the paraffin in order to expose the metal. The etching is done with undiluted nitric acid. If the etched lines are to be very deep, the work should be immersed in lukewarm water occasionally to remove the copper nitrate which forms in the etched lines. This will prevent the lines from spreading. It is only necessary to leave the work under water for a few seconds in order to remove the copper nitrate.

The preceding instructions also apply to etching steel with the important exception that the etching solution is composed of 1 part of nitric acid and 1 part of hydrochloric acid. The paraffin may be removed from the work by first dipping it in boiling water and then in cold water; this treatment causes the paraffin to contract and peel off.

For etching brass, a satisfactory ground can be made from equal parts of beeswax, Burgundy pitch, and asphaltum. These constituents are melted together and thoroughly stirred in order to secure a uniform mixture. This ground is warmed before using and spread evenly over the surface that is to be etched. After the ground has had time to cool, it is removed from those sections of the metal that are to be etched, after which the etching fluid is applied. A satisfactory etching fluid consists of 1 part of nitric acid to 4 parts of water. After the etching has been completed, which takes only a few minutes, the work is dipped in hot water to wash off the acid. The surface of the work can then be cleaned by wiping it with a cloth dipped in benzine or gasoline.

For use on brass castings, the following method is recommended: After cleaning the work with gasoline, place it in clean boiling water. A pot of beeswax is melted and kept at a temperature of from 200 to 250 degrees F., by standing it on a gas plate or some other heater that will retain the desired temperature. After the work has been washed, the surface to be etched is painted with wax and the work is then hung up to cool. The surplus wax will drain off and some sort of pan should be provided to catch the drippings. This process leaves a very thin coat of ground which adheres firmly to the metal. The preheating tends to bind the ground securely.

The following is a satisfactory formula for an etching solution: Nitric acid, 16 parts; hydrochloric acid, 4 parts; water, 100 parts. Dissolve 6 parts of potassium chlorate in 80 parts of water. The two solutions produced in this way are then thoroughly mixed and allowed to stand for a few minutes until the gases have escaped. The solution is then stirred, after which it is ready for use.

Etching Glass

A simple method of etching glass is to coat it with melted paraffin, and draw the pattern to be etched in the wax with a sharp needle point. Then expose the glass to the action of vapor of hydrofluoric acid, produced by the action of warm

hydrochloric acid on fluorspar. The gas must be generated in a lead vessel, as it attacks most substances. It is very poisonous, and therefore care must be taken not to inhale it. A little pigment is sometimes rubbed into the graduations to make them show more plainly.

Dry Etching on Glass

For dry etching on glass, as required for graduating volumetric glassware used in scientific laboratories, etc., etching and printing materials were obtained in time of peace from G. Mederow, Kettbuser-Strasse 8, Berlin S. O. 26, Germany. These include one bottle of salt and one bottle of printing ink (one kilogram etching salt under label Berliner Kalt-Aetzsals für E. Nienstadt's Trocken-Aetzverfahren U.S.W.) and ¼ kilogram printing material (Druckmasse) for a dry etching process. One kilogram of the salt costs about 15 marks ($3.57); ¼ kilogram printing ink, 5 marks ($1.19); postage, etc., about 5.20 marks ($1.24), which does not include duty.

In using this method of etching, it is necessary to use gelatine pads, which could probably be purchased from some of the companies making duplicating materials. However, these pads can be made by heating together over boiling water 100 grams of photographic gelatine, 160 cubic centimeters of glycerine, and 100 cubic centimeters of water. This will make six pads 0.5 by 5 by 20 centimeters in size. When thoroughly mixed, pour the liquid into molds which may be most conveniently made of five separate pieces. The bottom and three of the sides are made of pieces of brass held together by screws, while the fourth side is made of a plate of glass with the inside surface ground. This plate of glass is held in place by two clamps. Before filling the mold, a thin coating of grease or graphite is applied to the inside surface of the metal parts so that they may be easily removed from the gelatine pad after it has cooled. For stamping, the side of the gelatine pad is used that was next to the ground glass at the time the pad was molded.

A gelatine roller is made of the same mixture as the pads, and this roller is cast on a core of metal tubing which is left permanently in the roller. A convenient mold may be made of thin glass tubing, 2 centimeters in diameter and 7 centimeters long, into one end of which is fitted a stopper with a hole in the center. The core of 6-millimeter brass tubing is held in place by fitting one end into this stopper and the gelatine mixture is poured into the mold. After the gelatine has cooled sufficiently the glass tubing is broken away from it and the handle attached to the roller.

Next it is necessary to make a stamp corresponding in design to that of the marking it is desired to put on the glass. With the gelatine roller, spread a thin layer of printing ink on a smooth glass plate, and from this use the roller to apply a uniform layer of ink on the gelatine pad, by first running the roller over the ink on the glass plate and then over the pad until the proper thickness has been obtained. From the inked gelatine pad, the metal stamp is used to transfer an inked impression to a clean gelatine pad, care being taken not to press too hard with the metal stamp and also to re-ink the stamp before making each new impression.

These inked impressions on the gelatine pads are transferred to the glass, which is then sprinkled with the etching salt, using a camel's hair brush to remove excess salt from the glass where it does not adhere to the ink. The salt is then exposed to the action of hot steam until a clear narrow border appears along its edges with a slight cloudiness outside. After steaming, it may be found necessary to let the work stand for a few minutes, but as soon as the stamp appears to be finished it should immediately be wiped off. A good stamp should be white and clean cut.

Attention is called to the fact that the amount of time a salted impression is allowed to steam will vary considerably with atmospheric conditions, so that in order to obtain good results at any time, past experience in the use of the method will prove of value. Good results may be obtained by heating the salted impression over a gas flame until it turns to brown and then to white; but apparatus which has been graduated must not be heated to a temperature where deformation of the glass will cause a change in the volumetric capacity. The gelatine pads are cleaned by wiping them off with strong alcohol; water cannot be used, as it will dissolve the gelatine.

In order to obtain the best possible results, the etching salt should be perfectly dry and ground rather fine. If too coarse, it produces a ragged stamp, but if too fine a sufficient quantity will not adhere to the inked impression. The salt is dried by placing it in a metal can with a tight fitting cover, in which there is a small hole to allow water vapor to escape. This can and its contents are heated to about 50 degrees C., which may be done by setting the can in a water-jacketed vessel and running a stream of hot water through the vessel. After drying, the salt is powdered, and when not in use it is kept in a tightly covered vessel.

"Resists" Used for Graduating

Various acid-resisting materials are used for covering the surfaces of steel rules, etc., prior to marking off the lines on a graduating machine. When the graduation lines are fine and very closely spaced, as on machinists' scales which are divided into hundredths or sixty-fourths, it is important to use a thin resist that will cling to the metal and prevent any under-cutting of the acid; the resist should also enable fine lines to be drawn without tearing or crumbling as the tool passes through it. One resist that has been extensively used is composed of about 50 per cent asphaltum, 25 per cent beeswax, and, in addition, a small percentage of Burgundy pitch, black pitch, and turpentine. A thin covering of this resisting material is applied to the clean polished surface to be graduated, and after it is dry the work is ready for the graduating machine. For some classes of work, paraffin is used for protecting the surface surrounding the graduation lines to be etched. The method of application consists in melting the paraffin and raising its temperature high enough so that it will flow freely; then the work on which the graduating is to be done is held at a slight angle and the paraffin is poured on its upper edge. As the melted paraffin flows across the surface of the work, the latter will be covered with a thin protective coating.

* * *

ENGINEERING COUNCIL

Since its organization, June 27, the Engineering Council of the United Engineering Society has considered many matters coming both from the founder societies and from the councils' predecessor, the Joint Conference Committee of National Engineering Societies. The following standing committees have been appointed:

Public Affairs, C. W. Baker, G. F. Swain, S. J. Jennings, and E. W. Rice, Jr.; Rules, J. P. Channing, Clemens Herschel, N. A. Carle, and D. S. Jacobus; Finance, B. B. Thayer, I. E. Moultrop, Calvert Townley, and Alexander C. Humphreys.

The council has also created a War Inventions Committee, comprising H. W. Buck, A. M. Greene, Jr., and E. B. Kirkby, which will cooperate with the Naval Advisory Board and other departments at Washington, if desired, in the promulgation to engineers of war problems now before the government and for which there are opportunities for solution by means of inventions. In addition, a committee comprising George J. Foran, E. B. Sturgis, A. S. McAllister, and A. D. Flinn has been appointed to collect and compile such information regarding engineers of the country as will enable the committee to cooperate with the different departments of the Federal government on request and to assist in supplying the government's need for engineering services. While the council comprises only members from the four founder societies and of course can claim no right to speak for members of other societies nor for engineers at large, the members feel that the body will not have accomplished the results for which it was created unless it early establishes means of cordial cooperation with engineers, organized or otherwise. Every effort toward this end is contemplated.

* * *

The workshops of the South Manchuria Railway have recently built locomotives for the French railways in Cochin, China. They are of the ten-wheel type and weigh 103,000 pounds, with the tender.

HOW THE NIGHT SCHOOL CAN HELP

BY C. S. COLER [1]

Education is a basic need for the development and growth of an industrial nation, plant, or worker. The education at present provided in this country comprises fundamental knowledge, mental training, and manual skill required as a foundation for practically any line of work; that required as a foundation for work in a certain profession or industry; and the specialized knowledge, mental training, or skill required in the performance of a special line of work in a certain profession or industry. The last is supplied by apprenticeship courses and corporation schools.

In every industry, there is a surprisingly large number of workers who have valuable inherent characteristics that have not been made highly productive through education. Statistics show that fifty out of every hundred students who start in the public schools drop out before completing the sixth grade, and that only about nine out of every hundred complete high school. The night school offers an opportunity for those who have had insufficient training, but who possess an ambition to rise through merit, to make up their deficiency in education.

The Casino technical night school, located in the midst of the Westinghouse industries at East Pittsburg, Pa., shows what a night school can do to help both the worker and the industry. The courses cover the fundamental principles underlying manufacturing and engineering, but for those who have not sufficient elementary education to take up this engineering course, a brief preparatory course is offered in grammar-school

Fig. 1. Class in Machine Shop Practice

subjects; also a course in English is provided for those of foreign birth. A separate department is conducted for women, which offers courses in commercial subjects and household arts.

The Casino school was established fifteen years ago, with two instructors and a few students who wanted to learn drawing; this year, 1100 students have registered, and the faculty numbers sixty-three. The expenses of the school are borne by those primarily interested; *viz.*, the students, through a small tuition charge; the local industries, through annual appropriations; and the local communities, through annual appropriations in proportion to the number of students in the school residing therein.

The school is conducted in the local school buildings, which are rented from the school boards. The classes meet from 6 to 9 P. M., Monday, Wednesday, and Friday evenings, from early in September to about the first of June. Special shops and laboratories have been constructed in the basement of these buildings to take care of subjects not taught in the public schools. The instructors are men and women from the local industries. The strength of the school, in fact, lies in the ability of its faculty to interpret correctly and quickly the demands of the industries. Te instructors assign tasks, set the standards of work, inspire the students to effort, and check their work. The students learn by doing. There is little difficulty with discipline, as the students pay their money and spend their time to receive a definite benefit.

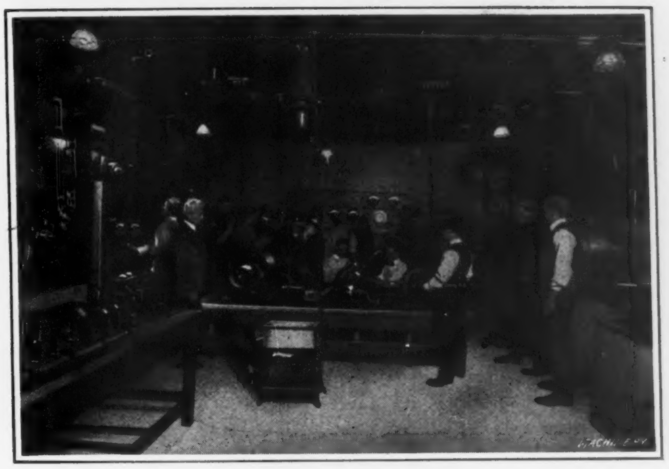

Fig. 2. Test in Electric Laboratory

Besides the class-room subjects, students handle all of the outside student activities through their own organizations. In this way they receive experience in organizing and dealing with men, and those students with special abilities soon get into positions where they have an opportunity to make use of them.

The engineering course, open to those who have successfully completed eight years of grammar school or the equivalent, is the nucleus around which all the activities of the school are grouped. This course aims to cover, in four years of night school, the fundamentals of the subjects taught in high school and college. The work in this department may be grouped under three headings: (1) Science, which deals with the material things used in engineering and the laws that govern them; (2) mathematics, which supplies the tools to be used in analyzing conditions and applying laws; (3) expression, which includes the various means of making engineering useful to the world. The subjects taught are as follows: Science—physics, chemistry, metallurgy, electricity, and steam; mathematics—shop problems, algebra, geometry, trigonometry, and mechanics; expression—drawing, patternmaking, foundry, machine shop, physics laboratory, chemistry laboratory, metallurgy laboratory, steam laboratory, electrical laboratory, and English. Problems are used throughout the course as a means of imparting knowledge and developing originality in application.

Each student is graded in judgment, thoroughness, personality, reliability, initiative, and health; besides his term grade in each subject is taken. Every effort is used to keep in close touch with the students and with the local industries with the view of ultimately placing each student in the kind of work which he is best suited to perform.

The growth of the Casino technical night school indicates that it fills a need in industry. It is probable that schools of this nature could be profitably started in connection with many of the industries of the country.

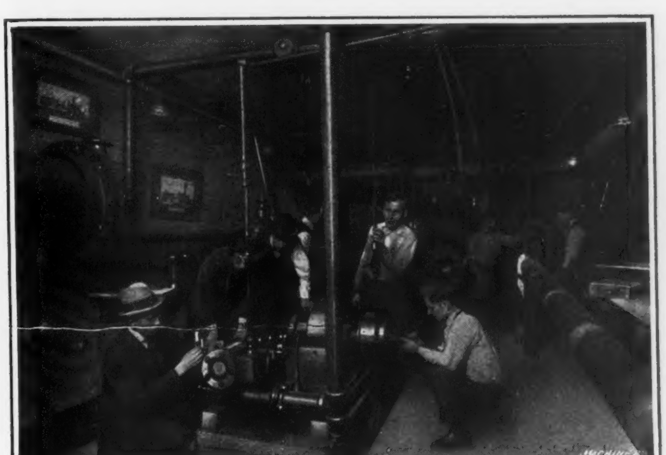

Fig. 3. Test in Steam Laboratory

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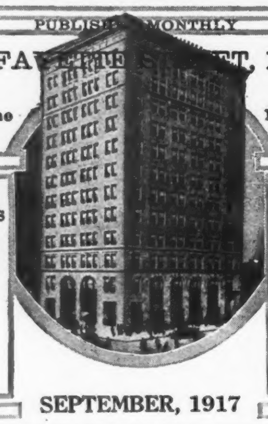

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MACHINISTS AND TOOLMAKERS IN WAR

The exemption boards that pass on our drafted men will be well advised if they excuse high-class machinists and toolmakers employed by machine tool builders, aeroplane makers, small tool manufacturers, gage-makers and concerns having government contracts for guns, gun carriages, motor trucks and other equipment. These men are vitally necessary for the equipment and maintenance of our soldiers at home and abroad. Without guns, shells, aeroplanes and equipment in unstinted numbers, an army cannot be highly effective, and these cannot be furnished without the assistance of the machine tool builder, the skilled machinist and the expert toolmaker. Our allies learned this in the early days of the war, when they found it necessary to recall such men to their industrial pursuits, as their products were vitally necessary for the support of the armies in the field.

* * *

THE MAN WHO STUDIES EVENINGS

The editorial department of MACHINERY receives many requests for information and advice from men engaged in mechanical work. These correspondents ask for guidance in their efforts to improve their condition by studying mechanical literature in spare time. While many of the letters require definite replies, according to the conditions in each individual case, there are two general principles involved in all study that every man educating himself should understand. These are the necessity for a definite purpose and for a definite plan in the study. A great many men who have not had the advantages of a technical school training, or even of an apprenticeship, are ambitious to secure better positions by self-education, but are perplexed to know where to begin and what to study. The result is that much energy and time are wasted. Frequently, machinists take up mechanical drawing with the idea that the draftsman has a better job. Perhaps he has, but it is also true that many machinists who study to become draftsmen might ultimately have obtained better positions if the same amount of time had been devoted to the study of general manufacturing methods and shop practice, with a view to becoming shop foremen or superintendents. Many other examples of misguided effort, due, usually, to a misapprehension of the conditions, could be cited to prove that the best opportunity is often the one nearest at hand. The machinist or machine operator is frequently allured by the prospect of clean work in the drafting-room; but, in many cases, he has only a vague idea of what a competent draftsman needs to know. Generally speaking, it is more difficult to obtain, by self-education, the amount of knowledge required for advancing very far as a designing engineer than it is to obtain the knowledge required for an equally good position in practical shop work.

A definite plan is as important as a definite purpose. In the building of a machine, a definite order of procedure is essential. In the case of a new mechanical development, the designer or inventor must first know the requirements. The general type of mechanism or machine which is expected to meet these requirements is first roughly sketched, and is then carefully designed. Detail drawings are then made, and the parts are shaped from iron and steel in accordance with these drawings. Finally these parts are assembled and the finished machine is tested. The entire procedure follows a definite plan. When studying the principles of machine design or construction, it is equally important to proceed in an orderly and systematic manner. While it may be possible to acquire considerable knowledge by haphazard reading, it is obvious that the same information may be obtained with an expenditure of less effort and time if the student takes up the different subjects in their proper order. In fact, unless a systematic method of reading were adopted, it might be almost impossible to obtain a clear understanding of many important branches of engineering and machine manufacture; hence the necessity of studying text-books which are logically arranged, in addition to reading current mechanical journals. The text-books will supply the fundamental principles, while the mechanical journals will keep the reader posted on the constant advance made in the mechanical field.

* * *

PROGRESSIVE INSPECTION AND ASSEMBLY

The inspection and assembling of parts of motor cars, shells, fuses and other products manufactured in large quantities has been revolutionized by the use of belt and chain conveyors. Progressive inspection and assembly facilitates the passage of work through the factory and sets the pace for the workers. It seems destined to become common in manufacturing plants in which the parts made are of a nature that permits them to be handled advantageously in this manner. Briefly, the general scheme is to provide a moving belt or chain set at a convenient working height on which the parts to be inspected or assembled are carried slowly by the workmen who stand or sit beside it. As a part passes a given station the workman at that station inspects it, using gages for making the test required. If the part is defective it is permitted to pass no farther and is cast into a rejection box beneath or beside the conveyor. The rejected parts are thus separated according to the nature of their defects, and if they can be saved by remachining, they are sent to the machines for drilling, reaming, threading or whatever operation is required. The inspected parts that pass all tests proceed to the assembling tables, where they are united with their components. In the case of the progressive assembly of motor car engines it is necessary to provide transverse conveyors for bringing the parts to the assemblers at the points required. These are usually placed overhead when the nature of the parts permits them to be hung on the conveyor, and picked off as wanted.

Among the advantages of progressive inspection and assembly are: concentration of workers and increase of production in a given area, regularity and uniformity of product, elimination of inefficient and lazy workers, general increase of workers' efficiency and intensive production. The principal disadvantages of the system are initial cost of installation and lack of flexibility when changes of routing become necessary. The latter in many cases can be overcome by building the conveyors in comparatively short units with means for interlocking with other units and transferring the work from one belt to the next. The system can be used effectively, of course, only when the output is of sufficient volume to warrant the installation of costly conveyors and the training of workers.

LUBRICATION

BY E. N. P.

In designing machinery the one point that seems to be generally neglected is provision for lubrication. After the machinery engine or motor has been completed, advertising matter has been prepared, and the photographer has departed, someone asks: "Where shall we drill the oil-hole?" Someone else recollects that lubrication has to be provided for in some way—any old way to get the oil in will do. Perhaps a more than usually careful designer will recollect from his technical school training that certain types of bearings should be subjected to pressures not in excess of 50 pounds per square inch on account of lubrication limitations, and he designs accordingly. Strange as it may seem, this matter is overlooked, in spite of the fact that mechanism of any kind is absolutely dependent upon lubrication for its operation and ceases to operate when lubrication ceases.

Experiments by such authorities as Michell, Parsons and Kingsbury have attracted comparatively little attention from designers, in spite of the vast changes in design possible because of their researches. After extensive experiments with high-pressure lubrication, Kingsbury at one jump raised thrust bearing pressure from 50 to 1000 pounds per square inch, through his advanced understanding of lubricating films, and designed a thrust bearing based on this knowledge. He eliminated the old-fashioned thrust, with its multiplicity of horseshoes and manifold troubles, and substituted a single ring thrust of approximately one-twentieth of the surface. This was done by a design based on geometrical principles, which enabled the thrust bearing surfaces to align themselves automatically with the thrust ring. Michell accomplished much the same result with his marine thrust bearing, based upon wedge-shaped films of oil in which the oil entered at the large end of the wedge and progressed toward the small end by the dragging action of the bearing. Both inventors were able to increase pressures, simplify designs and economize in weight. Experiments by the Westinghouse Machine Co. with Kingsbury thrust bearings have demonstrated that pressures as high as 7000 pounds per square inch could be carried at full speed without breaking the oil film. In fact, babbitt was forced out of the bearing without breaking the oil film. Furthermore, the babbitt did not extrude from the bearing on the exit side, but on the leading side, at the point where the motion of the journal was against such extrusion. The reasons for this suggest a wide field for research.

Thesis work at Stanford University in California has demonstrated that journals rotating in lubricated bearings float on the oil film in a position eccentric to the bearing itself. This position is dependent upon attendant conditions, such as speed, pressure, character of lubricant, etc. Various investigators have shown that a bearing has a pump-like action, taking in oil at the point of least pressure and delivering it, when possible, at the point of highest pressure. If a bearing is carrying a load of 400 pounds per square inch, it will be seen, by attaching a pipe and connecting it to a pressure gage, that it will deliver oil at the point of highest pressure at 400 pounds per square inch. This principle has been made use of by the Westinghouse Machine Co. in connection with its reduction gears. High-pressure lubrication has been used for a step-bearing of vertical turbines. The pressures carried vary from 400 to 1000 or more pounds per square inch. The writer has heard of cases where two inches of the step-bearing would be ground away in fifteen minutes when the lubrication failed for that length of time. The success of extremely high-speed engines, such as the aeroplane or racing automobile type, is almost entirely dependent upon lubrication. In view of the tremendous possibilities that have been barely touched upon by these few investigators, would it not be profitable for institutes of research to specialize to some extent upon lubrication? It cannot be done by manufacturers of lubricants, because they have no facilities for machine design or experimental work. It can be accomplished, however, by institutions of learning, and by large manufacturers of engines, automobiles, etc.

There is reason to suppose that an aeronautical engine or automobile engine whose design was based primarily upon scientific lubrication could outstrip anything of its kind known at the present time in efficiency, smoothness of operation, silence and dependability, and other desirable features. For instance, the light radial type of aeroplane engine used on high-speed planes today cannot run over six to twelve hours without thorough overhauling and rebuilding. Few technical men are aware of this, because of the highly specialized character of aeronautical design. The maximum pressure on aeronautical engines exceeds in some instances 1000 pounds per square inch. Automobile engine bearing pressures exceed 400 to 500 pounds per square inch. All these engines are lubricated by circulating oil systems or oil splash systems. Some are called forced feed, but, speaking scientifically, there is no such thing as a full forced feed system of lubrication, unless the pressure per square inch exceeds the maximum bearing pressure per square inch. In other words, in order to guarantee that the surfaces of an aeroplane engine be held separate by the oil film, it would be necessary to maintain that film under a pressure exceeding 1000 pounds per square inch. This is possible and is well within the limitations of what has been accomplished with pumps, but it cannot be done with geared pumps, rotary pumps or other devices of this kind. The oil-pump should be preferably a slow-running triplex plunger pump geared to the engine. It should not have large capacity nor be excessively heavy. It is probable, however, if such a lubricating system were carefully designed and the engine built around it, that an aeroplane engine could be constructed that would run indefinitely without wearing out.

The writer knows of a cheap automobile that had to be overhauled about every 10,000 miles. It was equipped with so-called "forced feed" lubrication at 12 pounds pressure. The owner finally fitted the engine bearings very close and built a pump capable of delivering oil in ample quantities at 250 pounds pressure. While this did not comply with theoretical requirements, it was a great improvement. The car has been running about 65,000 miles and as yet needs no attention to bearings, pins or cylinders. Another owner has obtained remarkable results by having pistons cast in the rough with deep relief between the rings. After the ring grooves were turned, babbitt was cast between them and turned to 0.002 inch clearance. This automobile has been running for a good many months now and has given the greatest satisfaction. The cylinders when measured recently showed no measurable wear. The pistons have worn slightly, but hardly enough to measure. If they do wear, it will simply be necessary to sweat on more babbitt, turn them up again and replace them in the engine.

The mechanical efficiency of automobile engines varies from 75 to 95 per cent. This 5 to 25 per cent loss is almost exclusively a question of lubrication. In order to get a racing engine, designers will cut pistons down to mere skeletons, lighten up cylinders, lighten up all movable parts and increase the size of valves to the maximum. All of this is done to derive the advantage of a slight increase of mechanical efficiency, which could be fully realized by improving the lubrication. Would it not be worth while to first carefully design a lubricating system based upon research and then build the engine around it?

The hardest part of an automobile engine to lubricate is the wrist-pin, and it is the part that needs lubrication the most. Manufacturers will go to considerable expense to install an oil-pump that pumps from the bottom of the crank-case to the upper pan, or that pumps from the bottom of the crank-case to the bearings, from the bearings to the crankshaft, and through the crank web to the crank-pins; there they will stop, because it is too expensive to provide means for the oil to travel from the crank-pin to the wrist-pin. The wrist-pin, cylinder and piston are left to the uncertain splash system. It is probable that the splash system and other features of cheap lubrication are responsible for 90 per cent of the guaranty expense of automobile manufacturers. It would be far cheaper, both in initial cost and in the long run, to build a cheap engine around a high-grade lubricating system than to build a high-grade engine around a cheap lubricating system.

There are probably not one hundred men in the United States today who know what lubrication is or what it means.

How many technical men or engineers know the character and dimensions of the lubricating oil film? How many know the principles of surface tension and capillarity as applied to oil films? How many have seen the oil film under the microscope? How many know what machine finished surfaces are like under the microscope, with their ragged and torn furrows, ripped and made jagged by the finest finished tools or abrasives? What should be the thickness of this film under various conditions of speed, pressure and temperature? One side of this film is anchored to the journal and the other side to the bearing. The tremendous shearing to which the film is subjected under these circumstances can better be imagined than described. What becomes of the great amount of heat generated by the agitation of the film? What effect has it on the oil? What oils can best stand up under this treatment?

An investigator recently was much astonished to find that the lubricants in the crank-cases of automobiles, tractors, aeroplane and other high-speed engines contained from 25 to 75 per cent of condensed fuel. The writer was so amazed and incredulous at this statement that he made a private investigation and found it to be the case. Another investigator, who wholly failed to realize the importance of his discovery, found that a part of the dark color of lubricants that have been in use for a short time is due to particles of metal of colloidal fineness. This can be demonstrated by grinding up bright silver by certain scientific methods until it is so fine that it will hang in water without falling to the bottom, when it will be seen that the water will appear black and not silver colored.

The importance of a deeper and more far-reaching study of lubrication will be realized when one considers that if lubrication were perfect, no bearing would ever wear out. It is the occasional failure or partial failure of lubrication that causes bearings to wear. The most unpleasant feature of modern automobiles is the necessity of periodical overhauling. This overhauling is confined almost entirely to the motor. The other parts of the car have roller or ball bearings on which the wear amounts to practically nothing. There is a difference of opinion about the use of roller bearings in the motor, but the majority of manufacturers use plain bearings and pins and depend upon lubrication for results. The annual overhauling of such a motor costs anywhere from $25 to $150. The average purchaser is not advised that this financial calamity is impending when he purchases the car. He finds this out after the first year or two, and the majority of purchasers become disgusted, thinking it a weakness of their particular make of car rather than the common ill of all cars. The average purchaser has no realization of the fact that these motors are contracted for by the thousands, and that many different cars have the same motor, just as one can buy a hundred different cigars all made from the same tobacco. As a matter of fact, the writer has never yet seen a bearing wear out that was oiled under extreme high pressure, say in excess of 400 pounds per square inch, unless the lubrication failed. It is probable that much expensive construction, high-priced bronzes and other expensive details, could be modified, if not entirely eliminated, by the development of scientific methods of lubrication.

* * *

SIMPLE RELIEVING ATTACHMENT

BY CHARLES JOUVE AUX SEGUINS [1]

The writer was interested in an article published in the March number of MACHINERY in which Warren H. Dunbrack described a fixture for relieving the teeth of milling cutters. During the early days of the war, the factory in which I am employed required a number of thread milling cutters for use in machining 75-millimeter shell and fuse bodies, and the accumulation of work which all toolmaking plants had on hand made it impossible to have this work down outside. Consequently we were forced to turn the order over to our own tool-room, and as we had only one universal lathe equipped with a relieving attachment, it was necessary to provide some special form of equipment. In a back number of *La Machine Moderne*, I found a description of a patented apparatus for relieving the teeth of milling cutters and adapted the principle of this apparatus in working out the design of a relieving attachment which gave very satisfactory results. As this type of apparatus is new to me, I thought it might prove of interest to the readers of MACHINERY.

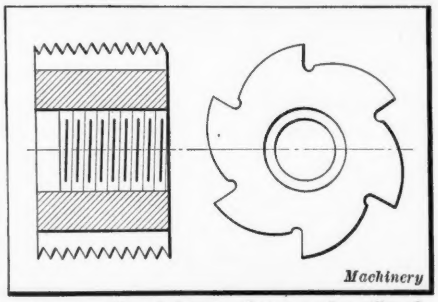

Fig. 1. Thread Milling Cutter to be relieved

Fig. 1 shows the type of thread milling cutters that we had to relieve, and Fig. 2 shows three views of the relieving attachment finally developed for this purpose. The design may be modified according to the requirements of the work or to meet the ideas of different tool designers. The most unusual feature of this attachment is that both the master cam *A* and the cutter *B* which is to be relieved are carried on the same arbor. It will be seen that the steel block *C* that runs in contact with cam *A* is carried at the end of a square bar *D* which is a sliding fit in the relieving attachment. Near the opposite end of this bar there is a horizontal slot into which a short lever *E* projects, which is carried on a pivot *F*. Relieving tool *G* is also carried by a sliding bar shown at *H*.

In operation, bar *D* is pushed back through the action of cam *A*, thus causing lever *E* to rotate about pivot *F*. The short end of lever *E* runs in contact with block *I* carried on tool-holder *H* and thus causes the tool to be advanced toward the work. Spring *J* resists this movement, thus taking up all lost motion in the attachment. Final adjustment of the position of the relieving tool *G* is obtained by a screw actuated by handwheel *K*; and it will be apparent that the relative sizes of master cam *A* and tool *B* are the same as the ratio of the long end of lever *E* to the short end.

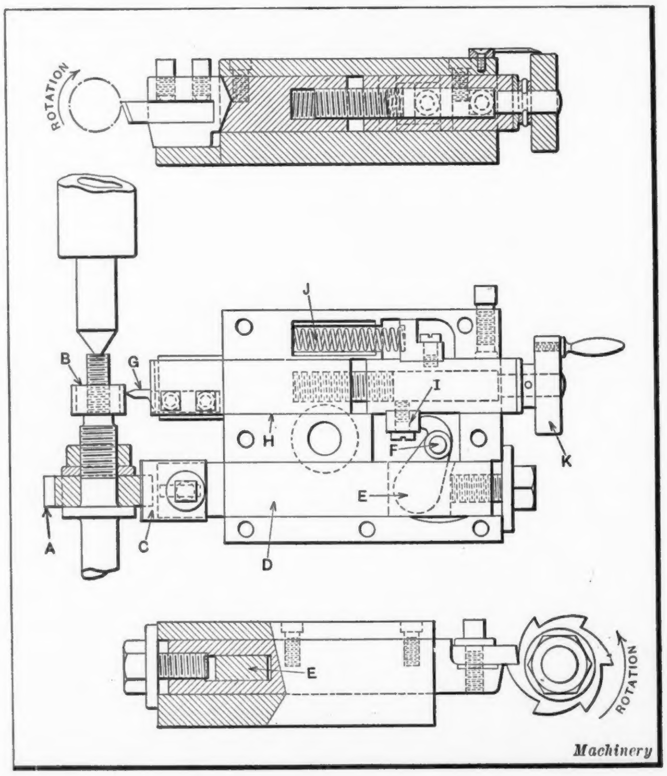

Fig. 2. Attachment designed for relieving Cutters of Type shown in Fig. 1

* * *

The "Pertinax" pipe, which is one of Germany's latest metal conserving devices, is formed of paper which has been wound spirally around a core and then secured in that form with a synthetic gum. Tests have shown that these pipes will stand the same internal pressure as copper pipes of the same weight and three or four times as great an internal pressure as lead pipe nine times their weight. They are to be used for gas or oil, and for insulating electric wires, and are also being tried out for carrying hot water under pressure.

[1] Address: Ruelle (Charente), France.

GRIDLEY TURRET LATHE EQUIPMENT—2

TURNERS, DRILLING ATTACHMENTS, DIES, TAP-HOLDERS, AND TAPER-TURNING ATTACHMENTS

BY DOUGLAS T. HAMILTON[1]

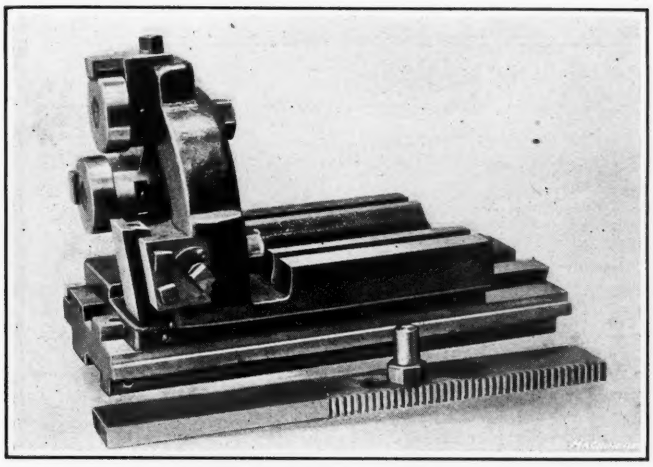

Fig. 20. Special Turner for Use on Gridley 4¼-inch Automatic Turret Lathe

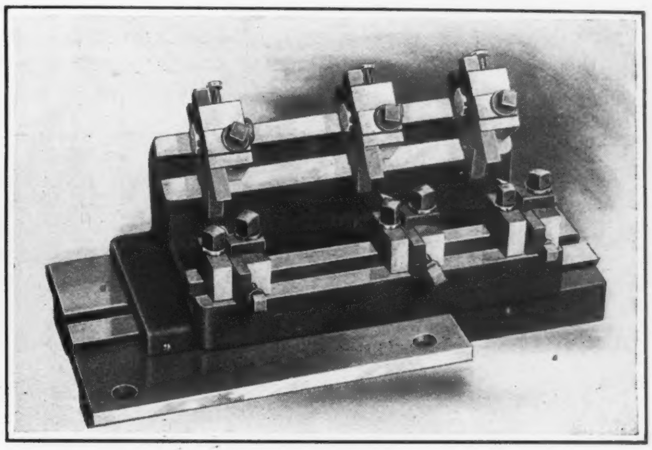

Fig. 21. Finishing Slide for handling Long Turning Operations on Gridley Automatic Turret Lathe

THE standard turning tools described in the August number of MACHINERY are adapted for the average run of work. However, when the work is of such length that the distance to be turned is greater than eight inches—the standard travel of the turret slide—a special type of turning tool is necessary. Two different turning tools for handling long turning operations will be described in the following, as well as additional tool equipment and attachments adapted for use on the single-spindle type of machine.

Special Turner for Use on 4 1/4-inch Machine

A special turner for handling long work is shown in Fig. 20. This turner, it will be noticed, is provided with two slides. One slide occupies the same groove in the turret face as the regular tool-slide, the latter being removed when using this special tool. The top slide, which carries the turning tool and supports, is attached to the turret face, and is operated through a pinion and rack; the latter is shown in the foreground of the illustration. The rear part of the top slide has two grooves in it. These are for attaching auxiliary turning tools, when such are necessary. The turning tool used is of the dovetail type, working on the end instead of the side of the bar. This tool is held in a slide, which provides for adjusting for diameter. Roller supports are used, and these are also held in the adjustable slide, as illustrated.

[1]Address: Fellows Gear Shaper Co., Springfield, Vt.

Finishing Slide

Another type of turning tool, known as a 12-inch finishing slide, is shown in Figs. 21 and 22. This slide will handle a turning operation of 12½ inches. It is not constructed for taking heavy roughing cuts, as these can be more satisfactorily handled with the regular turners placed one behind the other on the turret slide. This slide is operated in a similar manner to that shown in Fig. 20, but differs slightly in construction. With the arrangement shown in Fig. 20, the tool-holders and supports can be independently adjusted to the desired position. This feature is of especial advantage when finishing shafts having a series of shoulders of various diameters.

Fig. 22 shows the 12-inch finishing slide in operation on a handle, 14 inches long. In this case, the work is of such shape that only two turning tools can be used to advantage. The rear tool is used for reducing the end of the handle, whereas the forward tool finishes the straight portion.

High-speed Drilling Attachments

When it is necessary to drill a small hole in a large diameter bar, the best results can be secured by driving the drill at its proper cutting speed. This, of course, cannot be done without arranging a special driving mechanism for the drill, as the tools on the Gridley turret lathe are not rotated, but are held stationary. Fig. 23 shows the standard high-speed drilling attachment on the machine, and Figs. 24 and 25

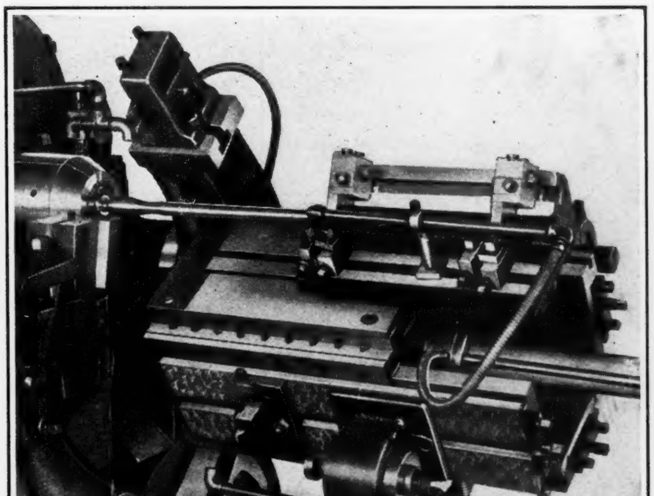

Fig. 22. Finishing Slide shown in Fig. 21, in Operation on a Handle that is 14 Inches Long

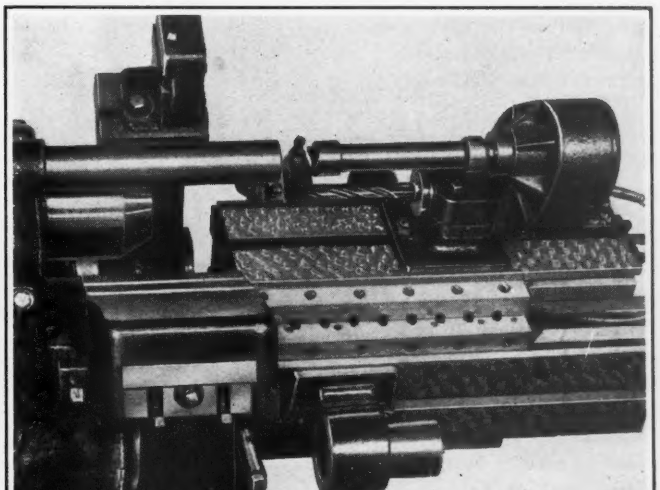

Fig. 23. High-speed Drilling Attachment used on Gridley Automatic Turret Lathe

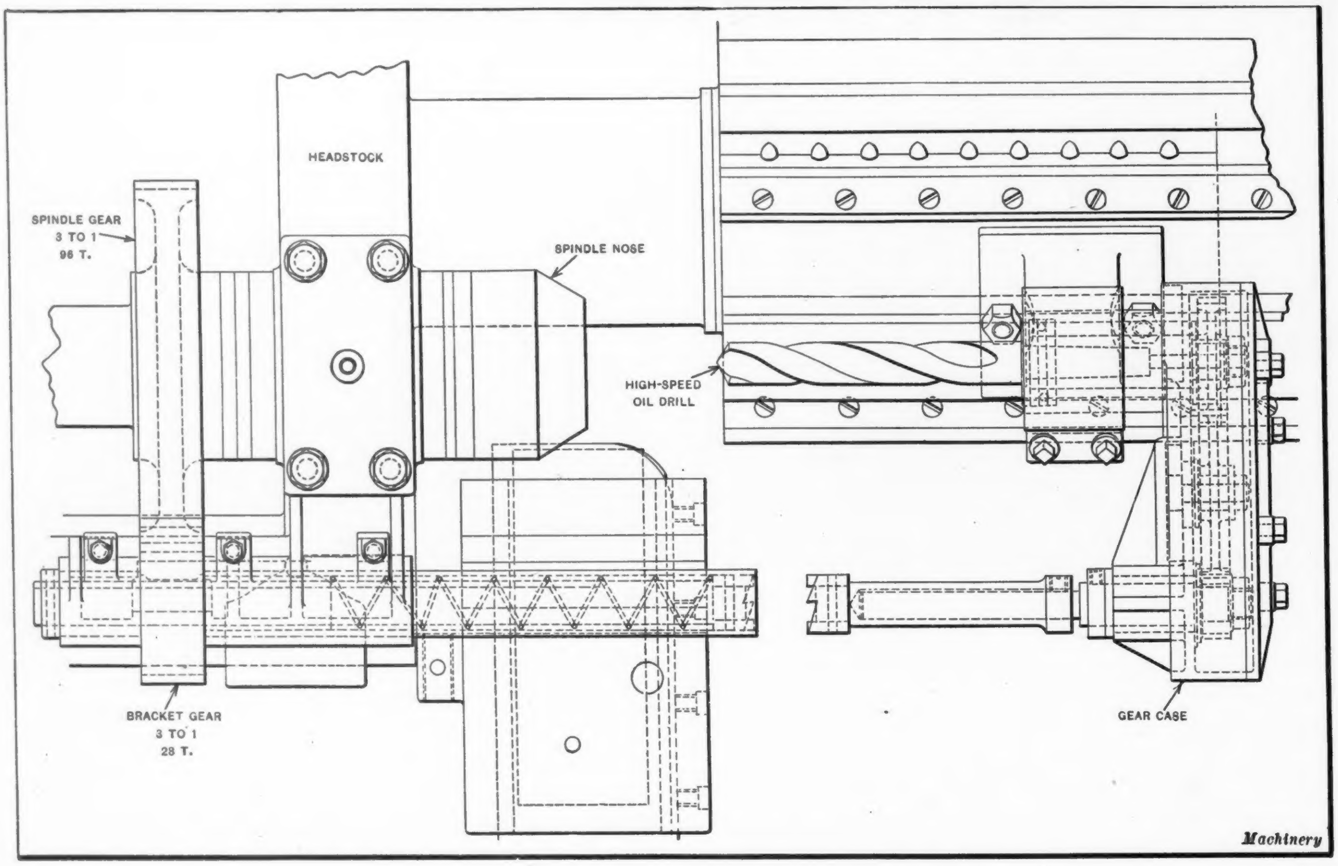

Fig. 24. Detail View of High-speed Drilling Attachment shown in Fig. 23

show a plan and an end elevation view, respectively, of the same device. This attachment is designed for use on the different sizes of automatic turret lathes. Reference to the illustrations will show that it consists chiefly of a bracket, which is clamped to the front of the machine and carries a gear meshing with the spindle gear. The spindle gear has ninety-six teeth and the gear on the drill-driving spindle, twenty-eight teeth.

The driving spindle is provided with a jaw clutch, which is pinned to it and is kept out by an open-wound spring. When the turret slide advances to the drilling position, this clutch engages with a similar clutch member on the drill-driving mechanism proper, which is fastened to the holder carried on the tool-slide. As the turret-slide advances, the clutch on the main driving shaft is forced back into the sleeve against the tension of the open-wound spring mentioned above.

The driving mechanism in the attachment held on the tool-slide consists of three gears, the driver, intermediate and driven gear, running inside an enclosed case. The driven gear is held on the spindle that carries the drill, the latter being supported in a regular tool-holder on the tool-slide. The arrangement of the driver, driven and intermediate gears can be more clearly seen in Fig. 25, where a sectional view of the driving spindle and drill-holder is shown; this view also indicates the relation of these members to the holder and the tool-slide.

The ratio between the number of teeth in the main spindle gear and the gear on the clutch shaft is 3 to 1. As shown in Fig. 25, the driving and driven gears can be interchanged, and when this is done four different drill speeds can be obtained with only two work-spindle speeds.

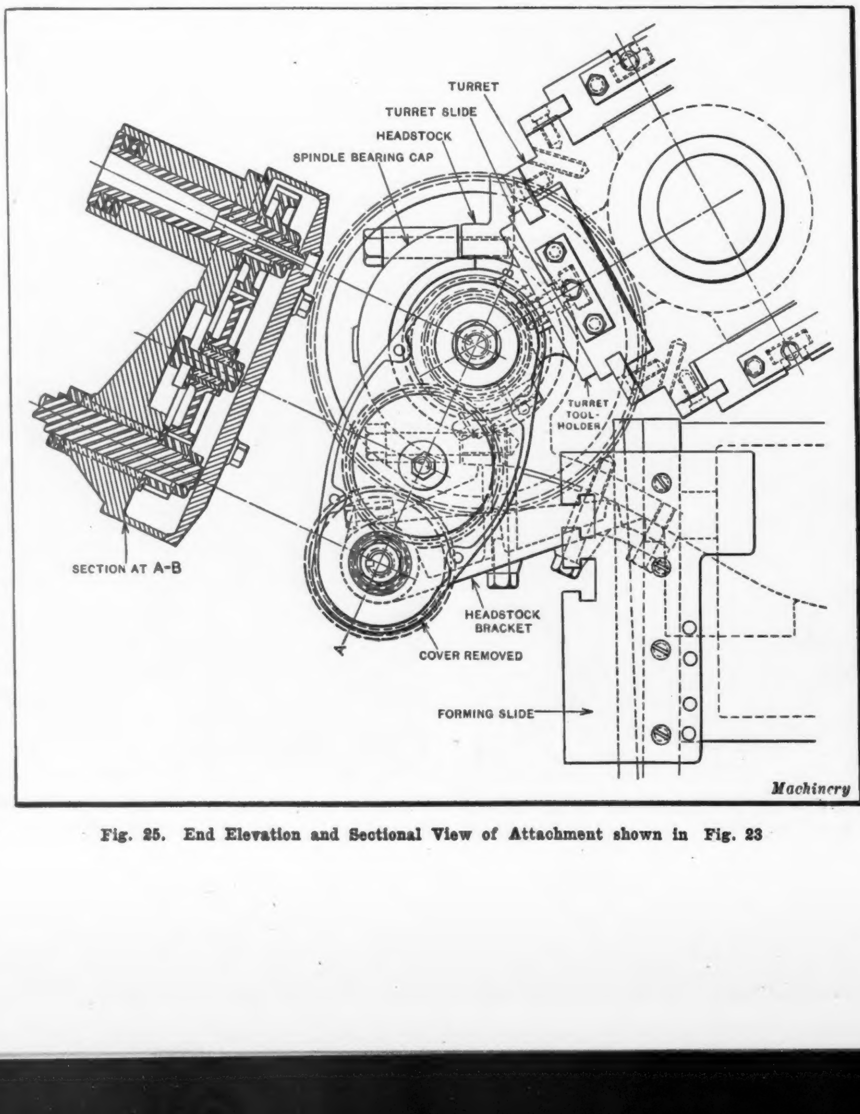

Fig. 25. End Elevation and Sectional View of Attachment shown in Fig. 23

Automatic and Solid Dies

Several different types of automatic dies can be used on the Gridley automatic turret lathe. Some of these are shown in Fig. 26. As a general rule, it is advisable to use an automatic opening die on this machine, but there are cases, of course, when it is necessary to use the solid spring die or the adjustable chaser die shown in Fig. 26. These particular dies will be described in connection with the multiple-spindle type of machine and will not be dealt with further at this time.

Automatic Die-opening Attachment

The automatic die-opening attachment used on the Gridley

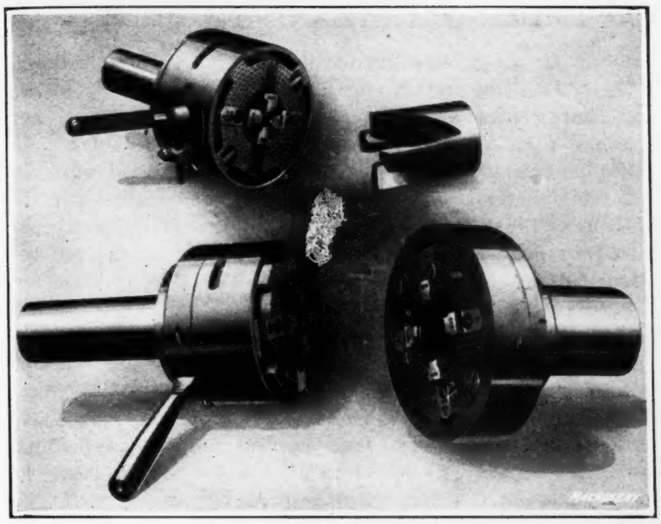

Fig. 26. Automatic Opening Dies, Adjustable Chaser Die and Spring Screw Die used on Gridley Automatic Turret Lathes

automatic turret lathe consists of a lever and cam operating the chasers in the die-head. This attachment is shown assembled and mounted on the tool-slide in Fig. 27, and dismantled in Fig. 28. Referring to the latter illustration, it will be noticed that it comprises a holder and two operating cams or brackets. The arm to which the bellcrank lever is attached is, in turn, fastened to a rod, which can be operated upon by the front bracket attached to the turret-slide for returning the die-

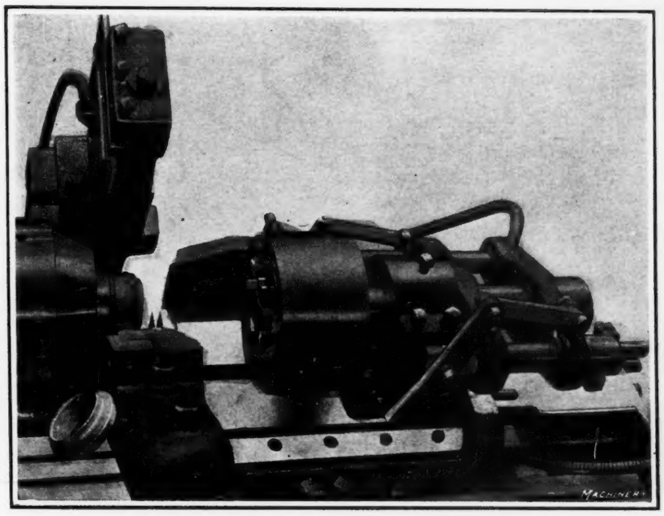

Fig. 27. Automatic Die Fixture in Operation on Gridley Automatic Turret Lathe

head; whereas the cam fastened to the rear part of the slide is used for closing the chasers. The die opens on the forward stroke, and closes on the return stroke of the tool-slide.

Releasing Tap-holder Attachment

When using a tap of the collapsible type on the Gridley automatic turret lathe, it is necessary to use a special attachment in connection with it, as shown in Fig. 29. This attachment does not differ materially from that used for the self-opening

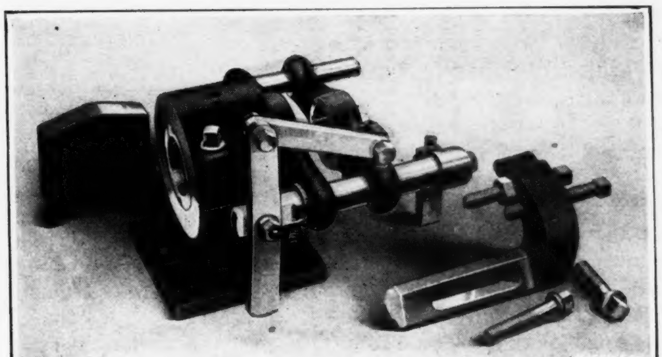

Fig. 28. Details of Automatic Die Fixture shown in Fig. 27

die, except in the method of operating the tap. As shown in the illustration, the chasers are collapsed by means of the operating handle on the collapsing tap-holder coming in contact with a pin that is held in a bracket on the tool-slide. The chasers are reset by the bellcrank lever coming in contact with the adjustable screw shown, which is held on a bracket on a corner of the turret. Both these brackets are adjustable, and the one on the tool-slide is set so that the chasers will collapse at the desired point, that is, when the tap has advanced to the desired depth. This illustration also shows a good view of the opening cam for operating the automatic die-head.

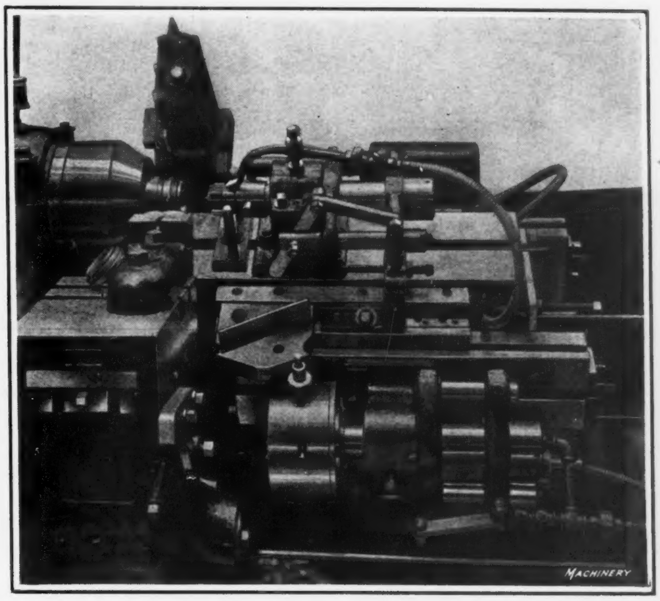

Fig. 29. Collapsing Tap Fixture in Operation on Gridley Turret Lathe

Fig. 31 shows a tapping attachment for carrying a tap that is not of the same design as the one illustrated in Fig. 29. In this case the tap floats and is held in a collapsing holder in which a large collar is used for collapsing the chasers. This collar comes in contact with the arm fastened to the corner of the turret, and is so placed that the rod illustrated prevents

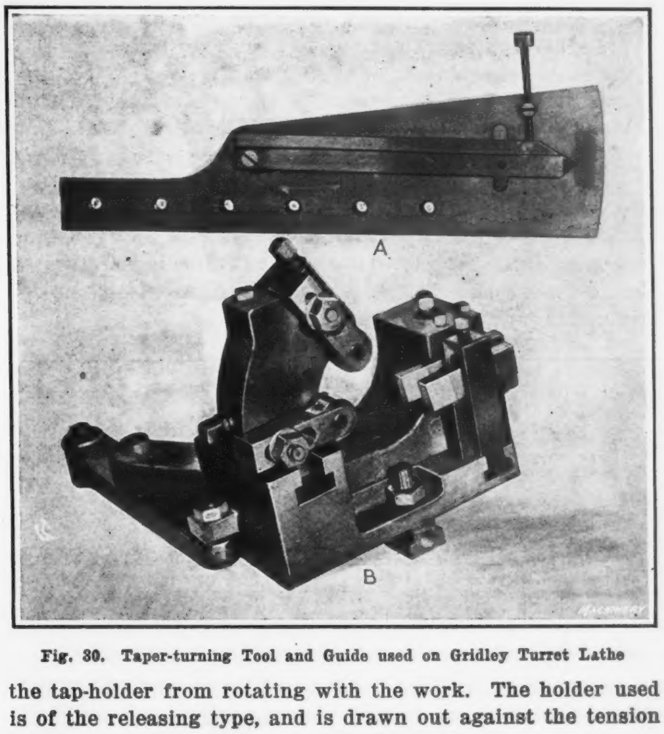

Fig. 30. Taper-turning Tool and Guide used on Gridley Turret Lathe

the tap-holder from rotating with the work. The holder used is of the releasing type, and is drawn out against the tension of a spring when it advances into the work.

Taper-turning Attachments

Taper turning can be accomplished on the Gridley automatic turret lathe by the use of a simple attachment, shown at *A* and *B* in Fig. 30. The taper guide, which is capable of being adjusted as shown, is fastened by screws to the turret, whereas

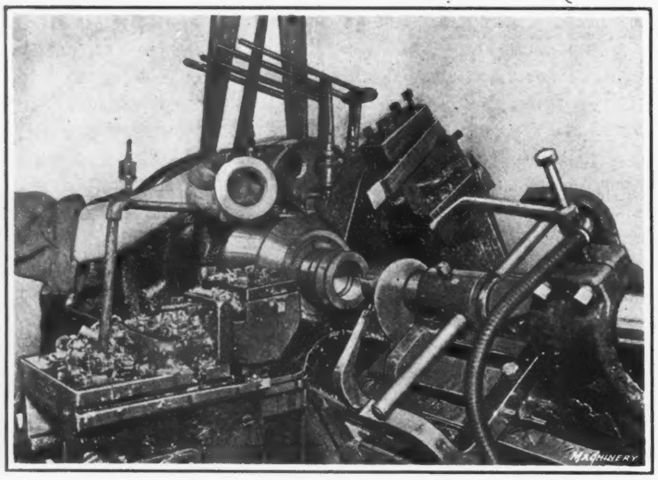

Fig. 31. A Different Design of Tap Fixture from that shown in Fig. 29

the turner proper is fastened to the tool-slide. A rod passing through the tool-holder and connected to a bellcrank lever, which carries a roll on its rear end, is operated by the adjustable taper guide. This particular taper turner carries two turning tools, and roller supports which are set in advance of the front turning tool.

Fig. 32 shows one of the standard taper-turning tools in use on the machine, and also a special taper turner, this particular job requiring the use of two taper-turning tools. The standard turner in this case is not provided with roller supports, the work being guided by a bushing support instead. It is operated in the same manner, however, as the taper turner shown in Fig. 30. The special turner, shown in back of the other, requires the use of a special tool-slide, which is cut away as shown to permit the insertion of the operating lever. This turner is operated by an adjustable taper guide, which is held on the turret as shown, and operates the holder carrying the tool through a lever that is fastened to a rock-shaft, held in the tool-slide.

* * *

An order for half a million scythes for Russia was recently handled by a large American export company. It is of interest to note in this connection that in the past there has been no market for American scythes in Russia on account of a lack of knowledge on the part of American manufacturers of the exact requirements of the Russian mower. A peculiar custom of the Russian farmer is to "hammer-sharpen" a scythe, making a special grade of steel necessary in its manufacture. The Russian scythes in the past have been supplied by Austria. Russian inspectors appointed by the Russian Ministry of Agriculture inspect these scythes in this country before shipping to Russia. It is likely that this market might have been obtained before the war had our manufacturers taken pains to discover the peculiar requirements placed by the Russian farmer on scythes.

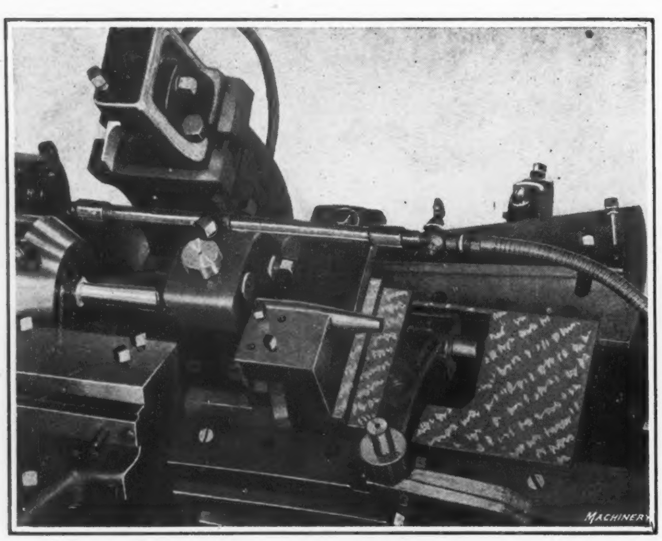

Fig. 32. Two Taper-turning Tools in Operation at the Same Time

MAKING AIRPLANE TIE-RODS

In the design of airplane parts, every precaution is taken to remove superfluous material. This applies not only to the larger units, such as the engine, main framework, etc., but to every part, however small. For example, a tie-rod, 55 inches long and 5/16 inch in diameter is threaded on both ends for a distance of 4 7/16 inches; as the weakest part of this rod is the bottom diameter of the thread on each end, which is practically ¼ inch, the entire section of the rod between the threaded parts is turned down to ¼ inch diameter at quite an expense in order to lighten the rod. This section is approximately 46 inches long.

It is interesting to note how the W. W. Oliver Co., Buffalo, N. Y., performs this operation on an ordinary engine lathe. After the rod is cut off it is held in an ordinary three-jaw chuck, with a little more than half of the rod protruding from the chuck. On the cross-slide ways of the lathe is clamped a special casting, which is bored out in line with the headstock and tailstock of the lathe so as to accommodate a split tool-steel bushing in which there is a hole that is just a running fit for the 5/16-inch rod. In the toolpost is held a small turning tool, set as close as possible to the front of the split bushing. In turning, the carriage is moved as near the chuck as possible, and after setting the tool to turn the rod to ¼ inch in diameter, the carriage is fed by power away from the chuck. The carriage is fed in this direction to within 4 7/16 inches of the end of the rod. This completes

Turning down Airplane Tie-rods

practically one-half the length of the rod, after which it is turned around in the chuck and the operation repeated on the other end.

This method of turning long, slender rods is a good one, but unless there is a short piece on the end of the rod that does not have to be turned down, it will be necessary to leave a little extra length as a support to be cut off afterward.

* * *

The failure of American firms to place sufficient postage upon their letters to foreign countries has again been called to our attention by a prominent South American firm. It is stated that while the larger firms never refuse mail on account of insufficient postage, many of the smaller firms find it necessary to refuse mail from the United States on which only the regular domestic postage is paid, owing to the heavy total outlay during a year that would have to be met on this account. It should be remembered that when letters are not properly prepaid, the addressee has to pay not only the amount lacking in postage, but double that amount, so that the payment made by the addressee is greater than what would have been the total postage if properly prepaid in the first place. This has been mentioned in the trade press numerous times, but as so many firms still seem to neglect this important matter in extending their trade, especially in the South American countries, it seems proper to call attention to it again.

THE SOLUTION OF EQUATIONS

METHODS USED FOR SOLVING EQUATIONS OF HIGHER THAN THE SECOND DEGREE

BY J. J. CLARK [1]

EQUATIONS may be divided into two classes—algebraic and transcendental. An algebraic equation is one that involves only the arithmetical operations of addition, subtraction, multiplication, division, involution, and evolution; a transcendental equation is one that makes use, directly or indirectly, of either or both of the transcendental numbers e or π. The number e is the base of the hyperbolic system of logarithms, its value being 2.718281828 +, and π is the ratio of the periphery of a circle to its diameter, its value being 3.141592653 +. Any equation, therefore, in which the variable occurs as a logarithm, an exponent, a trigonometric function, or an arc (inverse trigonometric function) is a transcendental equation.

The solution of algebraic equations has engaged the attention of mathematicians for hundreds of years, but no general exact solution for equations higher than the second degree has been discovered. Cardan's formula will solve a cubic equation, provided it has one and only one real root, but it fails if the cubic has three real roots. Descartes' solution will give the roots of the quartic, provided it has two and only two real roots, but it fails if the equation has four real or four imaginary roots. For equations of the fifth and higher degrees, it has been proved that no general exact solution is possible.

It has been proved that neither e nor π can be expressed by a finite number of figures, and that they cannot be expressed by surds, that is, by the use of radicals. Consequently, except in special cases, only approximate values of the roots of transcendental equations can be obtained; this is also true, in general, of algebraic equations higher than the second degree. Such equations, however, are frequently encountered by engineers, machine designers and draftsmen, who are, in most cases, unable to solve them. In practice, every equation has at least one real root; and the method here described, which may be called the method of interpolation, is easily learned and remembered. While in some cases it may entail more labor than other approximate methods, its details are simpler and it may be applied to any equation, which is not true of any other method known to the writer. In order to understand it thoroughly, a few of the leading principles of interpolation must be understood.

TABLE 1.

Argument x	Function $14 + x^3$	Differences: First	Second	Third	Fourth
1	15	..	..	..	..
..	..	7	..	..	..
2	22	..	12	..	..
..	..	19	..	6	..
3	41	..	18	..	0
..	..	37	..	6	..
4	78	..	24	..	0
..	..	61	..	6	..
5	139	..	30	..	..
..	..	91	..	..	..
6	230	..	..	..	..
(etc.)					

Machinery

In Table 1, the first column contains a series of numbers in arithmetical progression, the common difference being 1; these numbers are called arguments. The second column contains the values of $14 + x^3$ corresponding to the values of the arguments in the same row; these numbers are called functions. The numbers in the third column (written midway between the functions) are obtained by subtracting the first number in the second column from the second, the second from the third, etc., and are called first differences; thus, 22 — 15 = 7, 41 — 22 = 19, etc. The numbers in the fourth column are obtained by subtracting the first number in the third column from the one next below it, the second number from the one next below it, etc. They are written midway between the numbers in the third column, and are called second differences; thus, 19 — 7 = 12, 37 — 19 = 18, etc. The numbers in the fifth and sixth columns are called third and fourth differences, respectively, and are found in the same manner as the first and second differences. These subtractions are always downward and are always algebraic, and due regard must be paid to the signs. Thus, in Table 2, the first and third differences are negative and the second differences are positive.

TABLE 2.

Argument x	Function $3+\frac{1}{x}$	Differences: First	Second	Third
1.00	4.00000	....	..	..
....	....	—1961	..	..
1.02	3.98039	....	76	..
....	....	—1885	..	—5
1.04	3.96154	....	71	..
....	....	—1814	..	—4
1.06	3.94340	....	67	..
....	....	—1747	..	—4
1.08	3.92593	....	63	..
....	....	—1684	..	—2
1.10	3.90909	....	61	..
....	....	—1623	..	..
1.12	3.89286	....	..	..
(etc.)				

Machinery

In Table 3, the arguments are represented by x_0, x_1, x_2, etc., and the corresponding functions by u_0, u_1, u_2, etc. The first differences are represented by I_0, I_1, I_2, etc.; the second differences, by II_0, II_1, II_2, etc.; the third differences, by III_0, III_1, III_2, etc. The difference between any two consecutive arguments is always supposed to be constant, and is called the interval; thus, $x_1 - x_0 = x_4 - x_3 = x_2 - x_1 =$ the interval. In most mathematical tables the interval is 1, but in engineering and other tables it may be 2, 5, 10, or any convenient number; in Table 1 it is 1, but in Table 2 it is 0.02.

Now suppose it is desired to find the value of the function corresponding to an argument x that is intermediate between x_0 and x_1. Let $h = \frac{x - x_0}{x_1 - x_0}$, and denote the value of the function corresponding to x by u; then:

$$u = u_0 + h\left[I_0 + \frac{h-1}{2}\left[II_0 + \frac{h-2}{3}\left[III_0 + \frac{h-3}{4}\left[IV_0 + \text{etc.}\right.\right.\right.\right. \quad (1)$$

The symbol [indicates that the coefficient before it multiplies everything that follows it. In applying this formula, which is Newton's formula for interpolation, x_0 is taken as the

TABLE 3.

Argument x	Function $u = f(x)$	Differences: First	Second	Third	Fourth
x_0	u_0				
		I_0			
x_1	u_1		II_0		
		I_1		III_0	
x_2	u_2		II_1		IV_0
		I_2		III_1	
x_3	u_3		II_2		
		I_3			
x_4	u_4				
(etc.)					

Machinery

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argument next smaller than x and the various differences are found until they become zero (as in Table 1) or negligible (as in Table 2); then h is calculated and the formula worked backward, that is, from right to left. Thus, if the fourth difference is neglected, the third difference III_0 is multiplied by $h - 2$, the product divided by 3, the quotient added to the second difference II_0, the sum multiplied by $h - 1$, the product divided by 2, the quotient added to the first difference I_0, the sum multiplied by h, and the product added to the function represented by u_0.

Example 1—What is the value of $14 + 1.6^3$? Table 1 shows that the value of the argument next less than 1.6 is 1; hence, $h = \frac{1.6 - 1}{2 - 1} = 0.6$. Here $x_0 = 1$, $u_0 = 15$, $I_0 = 7$, $II_0 = 12$, and $III_0 = 6$; since the fourth difference is 0, the third difference, or 6, is multiplied by $h - 2$, or $0.6 - 2 = -1.4$, obtaining $-1.4 \times 6 = -8.4$. Dividing this by 3, the quotient is -2.8. Adding this to the second difference gives $12 + (-2.8) = 9.2$, which multiplied by $h - 1$, or $0.6 - 1 = -0.4$, gives -3.68. Dividing by 2 and adding to I_0, or 7, the sum is 5.16, which multiplied by h, or 0.6, gives 3.096. Adding this product to u_0, or 15, the sum is u, or $18.096 = 14 + 1.6^3$, as may be proved by direct multiplication. The calculation for the foregoing, as it would be ordinarily performed, is shown herewith.

$$\begin{array}{rr}
 & 6 \\
h - 2 = & -1.4 \\
\hline
3| & -8.4 \\
 & -2.8 \\
II_0 = & 12 \\
\hline
 & 9.2 \\
h - 1 = & -0.4 \\
\hline
2| & -3.68 \\
 & -1.84 \\
I_0 = & 7 \\
\hline
 & 5.16 \\
h = & 0.6 \\
\hline
 & 3.096 \\
u_0 = & 15 \\
\hline
u = & 18.096
\end{array}$$

Example 2—Find the value of $3 + \frac{1}{1.049}$. Table 2 shows that $x = 1.049$ lies between 1.04 and 1.06; hence, $x_0 = 1.04$, and $h = \frac{1.049 - 1.04}{1.06 - 1.04} = 0.45$. Here $u_0 = 3.96154$, $I_0 = -1814$, $II_0 = 67$, $III_0 = -4$, and the fourth difference is negligible. Consequently, $h - 2 = 0.45 - 2 = -1.55$, and $h - 1 = 0.45 - 1 = -0.55$. The calculation is shown herewith.

$$\begin{array}{rr}
 & -4 \\
h - 2 = & -1.55 \\
\hline
3| & +6.20 \\
 & 2.1 \\
II_0 = & 67 \\
\hline
 & 69.1 \\
h - 1 = & -0.55 \\
\hline
 & 3455 \\
 & 3455 \\
\hline
2| & -38.005 \\
 & -19 \\
I_0 = & -1814 \\
\hline
 & -1833 \\
h = & 0.45 \\
\hline
 & 9165 \\
 & 7332 \\
\hline
 & -824.85 \\
u_0 = & 3.96154 \\
\hline
u = & 3.95329
\end{array}$$

No attention is paid to the position of the decimal points in the differences, which are treated as integers, as is usually the case in calculations of this kind. Since, in general, when the tabular functions are not exact, we can obtain only as many figures correct as there are figures (or decimal places) in the tabular functions, the decimals are rejected each time before adding, as shown in the calculation. By actual division, $3 + \frac{1}{1.049} = 3.953288 +$, or 3.95329 to six significant figures, the same value as was obtained for u by the method of interpolation.

Finding the Argument for an Intermediate Function

Having shown how to find the function for an intermediate argument (and the method may be applied to any table when the differences become 0 or are negligible), it is necessary to show how to find the argument for an intermediate function. If the interval $x_1 - x_0$ is represented by m, $h = \frac{x - x_0}{x_1 - x_0} = \frac{x - x_0}{m}$, from which:

$$x = x_0 + mh \qquad (2)$$

Consequently, if h is known, x can be found by substituting in Formula (2). The value of h may be determined in the following manner: From Formula (1),

$$h = \frac{u - u_0}{I_0 + \frac{h - 1}{2}\left[II_0 + \frac{h - 2}{3}\left[III_0 + \text{etc.}\right.\right.} \qquad (3)$$

Since h occurs in the denominator of Formula (3), a series of approximate values for h, which will here be designated by h_1, h_2, h_3, etc., is calculated by means of the following formulas, all of which are derived from Formula (3):

$$h_1 = \frac{u - u_0}{I_0} \qquad (4)$$

$$h_2 = \frac{u - u_0}{I_0 + \frac{h_1 - 1}{2} \times II_0} \qquad (5)$$

$$h_3 = \frac{u - u_0}{I_0 + \frac{h_2 - 1}{2}\left[II_0 + \frac{h_2 - 2}{3}\left[III_0\right.\right.} \qquad (6)$$

When applying these formulas, find the value of h_1 to two decimal places, substitute in Formula (5), and calculate h_2 to four decimal places. If the difference between h_1 and h_2 is greater than five units when both are expressed to two decimal places, apply Formula (5) again, using the new value for h_1. If the difference between the two values of h_2 is greater than five units when both are expressed to three decimal places, express h_2 to three decimal places, and substitute in Formula (6); otherwise, express h_2 to four decimal places and substitute in Formula (6). The value obtained from Formula (6) will usually be correct to four or more decimal places; but if the difference between h_3 and h_2 is greater than five units when both are expressed to three decimal places, apply Formula (6) again, using the new value for h_2 expressed to three decimal places. The method is best explained by an example.

Example 3—Using Table 1, find the cube root of 41.305. Here $x^3 = 41.305$, so $14 + x^3 = 55.305 = u$. According to the table, this value of u falls between $41 = u_0$ and $78 = u_1$; therefore, $x_0 = 3$, $I_0 = 37$, $II_0 = 24$, $III_0 = 6$. Substituting in Formula (4):

$$h_1 = \frac{u - u_0}{I_0} = \frac{55.305 - 41}{37} = \frac{14.305}{37} = 0.39$$

Applying Formula (5):

$$h_2 = \frac{14.305}{37 + \frac{0.39 - 1}{2} \times 24} = 0.4820, \text{ or } 0.48 \text{ to two decimal places}$$

Since $48 - 39 = 9$, a number greater than 5, Formula (5) must be applied again, substituting 0.48 for h_1, when $h_2 = 0.4651$ is obtained. Since $482 - 465 = 17$, a number greater than 5, 0.465 is substituted for h_2 in Formula (6) and:

$$h_3 = \frac{14.305}{37 + \frac{0.465 - 1}{2}\left[24 + \frac{0.465 - 2}{3} \times 6\right.} = 0.4556$$

Since $465 - 456 = 9$, a number greater than 5, Formula (6) is applied again, using 0.456 for h_2; this gives $h_3 = 0.4568$. Since $4568 - 4556 = 12$, it is doubtful if 8 is the correct fourth figure for h_3; hence, substituting 0.4568 for h_2 in Formula (6), $h_3 = 0.45674 -$. Substituting this value for h in Formula (2), $x = 3 + 1 \times 0.45674 = 3.45674$. The value of $\sqrt[3]{41.305}$ correct to seven significant figures is $3.4567466 +$.

Although this may appear tedious, it is the only practical method that can be used in certain cases. This example is particularly difficult of solution, because the interval is very large as compared with the arguments. When the arguments are given to two or three figures, the work is much easier.

Practical Applications of Method

Example 4—In the December, 1916, number of MACHINERY, there is a request for a solution of the equation $3 \sec \phi + \operatorname{cosec} \phi = 5.7142857$. The equation is first written as $f(\phi) = 3 \sec \phi + \operatorname{cosec} \phi - 5.7142857 = 0$. It is known that ϕ is in the neighborhood of 45 degrees; hence, substituting in the equation, $f(\phi) = -0.057431$; for $\phi = 46$ degrees, $f(\phi) = -0.005453$. It is evident that for $\phi = 47$ degrees, $f(\phi)$ will be positive; that is, it passes through a root between 46 and 47 degrees. Now, assuming that as ϕ increases from 45 to 46 degrees, $f(\phi)$ increases from -0.057431 to -0.005453 at a uniform rate, and that it increases from -0.005453 to 0 at the same

rate, it will become 0 at $46 + 1 \times \dfrac{0 - (-0.005453)}{-0.005453 - (-0.057431)}$ $= 46 + 1 \times \dfrac{5453}{51978} = 46.1$ degrees, nearly, $= 46$ degrees, 6 minutes, which is, probably, the value of ϕ to the nearest minute. If a more exact value is required, a table should be made up, as shown herewith, making the interval 3 minutes, say, to

ϕ Degrees	ϕ Minutes	$f(\phi)$			
46	6	$+0.000036$			
			-2750		
46	3	-0.002714		$+11$	
			-2739		$+4$
46	0	-0.005453		$+15$	
			-2724		
45	57	-0.008177			

reduce the labor of calculation. The third differences are so small that they will have no effect whatever on the calculation, and may be neglected.

Applying Formula (4), $u = 0$, $u_0 = 36$ (neglecting the decimal points), $I_0 = -2750$, $II_0 = 11$, and $h_1 = \dfrac{0 - 36}{-2750} = 0.01309$.

Applying Formula (5), $h_2 = \dfrac{-36}{-2750 + \dfrac{0.01309 - 1}{2} \times 11} =$ 0.01307. The interval is -3 minutes, since 3 minutes $-$ 6 minutes $= -3$ minutes; hence, by Formula (2), $\phi = 46$ degrees, 6 minutes $+ (-3 \times 0.01307) = 46$ degrees, 5.96079 minutes $= 46$ degrees, 5 minutes, 57.65 seconds.

Example 5—Some years ago, the following problem was submitted to the writer by a machinist. Fig. 1 represents a flat ring from which a section *ABCD* is to be cut out. *AD* and *BC* are parallel to the middle radius *OE*. If $OB = 6$ inches, $OC = 4$ inches, and the area of the piece cut out is exactly 6 square inches, what is the length of *AB*? Let $AB = x$, $AD = y$, $AOE = \beta$, and $DOE = \gamma$. If x is known or assumed, $\sin \beta = \dfrac{AE}{AO} = \frac{1}{2}x \div 6 = \dfrac{x}{12}$, and $\sin \gamma = \dfrac{x}{8}$, from which β and γ can be found. $AD = 6 \cos \beta - 4 \cos \gamma$; area of segment $AEB = \dfrac{r^2}{2}(2\beta - \sin 2\beta) = 18(2\beta - \sin 2\beta)$; area of segment $DFC = 8(2\gamma - \sin 2\gamma)$; and area of $AEBCFD = AD \times AB +$ segment $AEB -$ segment $DFC = (6 \cos \beta - 4 \cos \gamma) \times x + 18(2\beta - \sin 2\beta) - 8(2\gamma - \sin 2\gamma) = 6$. The equation may be written $f(x) = (6 \cos \beta - 4 \cos \gamma)\, x + 18(2\beta - \sin 2\beta) - 8(2\gamma - \sin 2\gamma) - 6 = 0$. It would be practically impossible to solve this equation by any method other than the one here described. The first step is to assign a value to x; next find β and γ, then substitute in the equation and find $f(x)$. A brief inspection of the illustration will show that x must be nearly equal to, but less than, 3. Assume that $x = 2.9$; then $\sin \beta = \dfrac{2.9}{12}$, from which $\beta = 13$ degrees, 59 minutes, 6 seconds, and $\sin \gamma = \dfrac{2.9}{8}$, from which $\gamma = 21$ degrees, 15 minutes, 14.5 seconds. Substituting these values of x, β and γ in the equation, $f(x) = -0.11150$. For $x = 2.92$, $f(x) = -0.06981$; for $x = 2.94$, $f(x) = -0.02780$; and for $x = 2.96$, $f(x) = +0.01410$. It is not likely that the last figures of these results are correct, because of the multiplications and the use of five-place tables. Hence, dropping the last figures, arrange the results as shown in the table. Here the second difference is so small that it may be neglected, and $h = \dfrac{0 - 141}{-419} = 0.3365$. Since the interval is $294 - 296 = -2$, $x = 296 + (-2 \times 0.3365) = 295.327$, or 2.95327 inches, when the decimal point is restored. This problem is one of the most difficult of solution that the writer has ever encountered, and shows what an engineer is likely to meet with in practice.

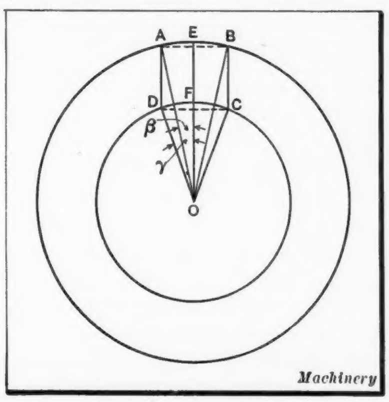

Fig. 1. Diagram illustrating Problem of cutting Exact Area from a Flat Ring

x	$f(x)$		
2.96	$+0.0141$		
		-419	
2.94	-0.0278		-1
		-420	
2.92	-0.0698		$+3$
		-417	
2.90	-0.1115		

Example 6—In MACHINERY for July, 1916, the following cubic equation occurs: $1.0472s^3 - 6.2832s^2 + 12.5664s - 0.233 = 0 = f(s)$. To solve this equation by the interpolation method, it is first necessary to find an approximate value of s. To do this, assume that in Fig. 2 $d = D = 4$; whence, $\dfrac{\pi}{12}(D^2 + Dd + d^2)s = \dfrac{\pi}{12} \times 3 \times 4^2 \times s = 4\pi s = 0.233$, from which $s = 0.0185$, nearly. Substituting this value of s in the given equation, $f(s) = -0.002666$. For $s = 0.0187$, $f(s) = -0.000198$, and for $s = 0.0189$, $f(s) = 0.002267$. Forming the table in the usual manner, the second difference is so small it can be neglected; whence, $h = \dfrac{0 - 2267}{-2465} = 0.9197$. Since the interval is -2, $s = 189 + (-2 \times 0.9197) = 187.1606$, or 0.01871606, when the decimal point is restored. The root correct to eight figures is 0.01871607 +.

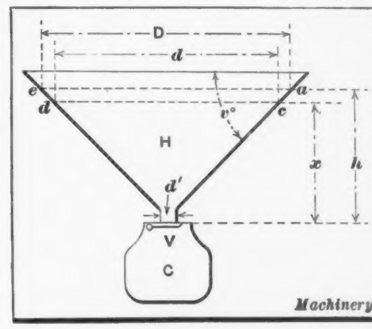

Fig. 2. Illustrating Size of Valve Opening for Discharging 0.233 Cubic Foot of Water per Second

s	$f(s)$		
0.0189	$+0.002267$		
		-2465	
0.0187	-0.000198		-3
		-2468	
0.0185	-0.002666		

It may here be stated that if the calculated (tabular) functions are not exact, but are limited to a certain number of significant figures or decimal places, as in the last three examples, the second and all higher differences may be neglected if less than 4, and third differences may be neglected if less than 8. It is also well to note that the value obtained for h is always positive—it can in no case be negative.

The greatest difficulty in finding the root of an equation lies in the determination of the first and second figures; when these have been found, the rest of the work is merely a matter of detailed calculation. In all practical problems, the first two figures can usually be determined quite accurately by exercising good judgment (as in Examples 4 and 5), by an approximate formula (as in Example 6), or by actual measurement from an accurate drawing; the latter is illustrated in the following example.

Example 7—In MACHINERY for January, 1917, a root is required of the equation $256y^4 + 6656y^3 + 43664y^2 - 1225 = 0 = f(y)$. By making an accurate construction of the diagram

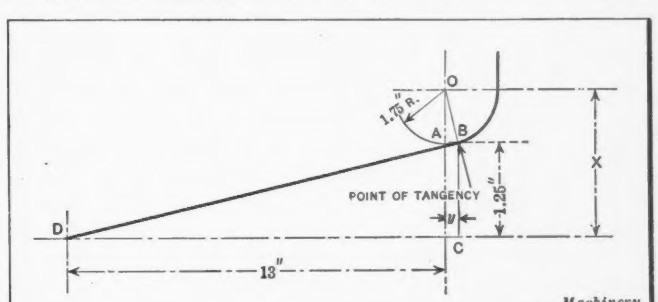

Fig. 3. Problem in designing Dies

shown in Fig. 3 and carefully measuring, y will be found to be about 0.15 inch. Substituting 0.15 for y in the equation, $f(y) = -220$; for $y = 0.16$, $f(y) = -80$; and for $y = 0.17$, $f(y) = +70$. Forming the table as usual, the second difference is 10, and must be considered. By Formula (4),

$$h_1 = \frac{0-(+70)}{-150} = 0.47; \quad h = \frac{-70}{-150 + \frac{0.47-1}{2} \times 10} = 0.46.$$

Therefore, $y = 17 + (-1 \times 0.46) = 16.54$, or 0.1654 when the decimal point is restored.

y	$f(y)$		
0.17	+70		
		−150	
0.16	−80		+10
		−140	
0.15	−220		

In obtaining the foregoing values of $f(y)$, the calculations were all limited to one decimal place, in order to save labor. Now substituting 0.1654 for y, $f(y) = -0.1677$; and for $y = 0.1655$, $f(y) = +1.3322$. These results show that the first four figures of y are 1654; it will not be necessary to calculate a second difference, since at least three more figures can be obtained by using first differences only. Hence,

$$h = \frac{0-(-1677)}{14999} = 0.1118, \text{ and } x = 1654 + 1 \times 0.1118 =$$

1654.1118, or 0.16541118 after restoring the decimal point. The root correct to nine figures is 0.165411186 +.

y	$f(y)$	
0.1654	−0.1677	
		14999
0.1655	+1.3322	

It may here be stated that if the argument has been found correct to three or more significant figures, and the interval is one unit in the last figure, either as many more or as many more less 1 may be obtained by using first differences only.

* * *

AN ANCIENT LATHE

BY GUY H. GARDNER [1]

One sometimes hears the wish expressed that a man of a century ago could return to earth, that we might hear his comments on the surprising changes that would greet his eyes. If such a visitor chanced to be a machinist, with what emotions would he examine the machine tools that have been evolved from the simpler forms with which he was familiar? What would be his standard of comparison and what images of the appliances of his day would their successors bring to his mind? What were the machine tools with which his shop was equipped and how much do we know of the state of our trade a century ago?

In his boyhood, old men told the writer of the chain planers of their apprentice days and of the times of their fathers when lathe carriages were not. Then the skill of the workman was depended on to operate and guide a tool of such proportions that the handle rested on the latheman's shoulder while the working end traversed the T-rest. At a later date there were lathes with a rack feed, for each of which floor space of twice its length had to be provided, one of which it was the writer's privilege some years later to see.

This lathe was credibly reported to have been built just before the war of 1812, and was in daily use seventy years later. It had a swing of twenty inches and its bed was twelve feet long. The bed consisted of three cast-iron pieces, twelve feet long, and four vees of ⅝- by 6-inch flat stock set on edge. The cast-iron pieces served as distance pieces, and the whole was united by dowels and tap bolts. The vees were planed to an included angle of 90 degrees.

The headstock was longer than is now usual in lathes of that size, for it was necessary to provide room for a wooden cone pulley of eight steps, there being no back-gears. Both spindles were of square steel, the only round parts of the live spindle being the bearings, the nose, and the projection at the left of the headstock. In this spindle, just inside the front bearing, was a slot for a drift to remove the center, but the tail-spindle had a hole through it and a push-rod held in place by a pin so that it could not be easily removed. From the enlarged end of this pin, battered by the hammer blows of successive generations of workmen, the writer removed a small splinter, which a metallurgist pronounced a pure wrought iron resembling so-called "Norway" (Swedish) iron. The center holes in this venerable relic had been reamed to a modern standard taper, but the original centers were preserved, the tapering portion being about 1½ inch long and tapering more than an inch to the foot; a long teat extended beyond the taper for the drift to act upon. The headstock boxes were of cast iron of somewhat complicated design, each having, besides the holding-down bolts, a pair of screws for raising and lowering the box as a whole and another pair for closing the halves more or less tightly upon the spindle. The writer was told that when the lathe was dismantled for overhauling a few years before, the boxes and bearings were in excellent condition. It was then also discovered that in both the headstock and the carriage bars of wrought iron were "burned into" the castings to add strength and rigidity. The faceplate bore against an unusually broad collar shrunk on the spindle. It had, besides three plain slots, three slots finished by planing and obviously designed to carry chuck jaws, but no one had ever seen the jaws.

Most remarkable of all were the feed arrangements. A rack attached to the under side of the carriage bridge extended beneath the headstock and meshed with a pinion on a horizontal shaft at the extreme left of the lathe. This shaft bore at its front end a handwheel and at the back a sleeve, which formed one member of a jaw clutch. On this sleeve was a wooden pulley that was driven by a belt from a pulley on the live spindle, two idlers being provided to guide and tighten the belt. When a change of feed was desired, the operator had to change the pulleys and adjust the idlers; and to reverse the direction of feed, he had to shift the quarter-twist belt. At the time of the writer's visit, a six-inch pipe flange had just been bored and was being threaded, pulleys being chosen for the proper lead of thread from a large collection hanging on the wall. The taper was obtained by mounting on the cross-feed screw a wooden disk, from the periphery of which a leather strap extended to a bracket at the right-hand end of the bed.

Something more than a hundred years ago, a settler in what was then a wild part of New England, far up the Connecticut River, brought by boat and installed in his log-cabin shop a lathe similar to that just described, and with its aid constructed rifles of such excellence that tales of their accuracy were current in the neighborhood within the writer's memory. To one of these, said to have been the maker's masterpiece, a descendent added a telescopic sight, all the metallic parts of which were made on the old lathe; but whether the grinding of the lenses was done by the same machine, tradition does not reveal. While we are not told how this maker did the rifling, the manner of boring the barrels has been preserved. He kept among his tools a well-seasoned beech log that was bored to fit the outside of the barrels. Driving the barrel into this, after turning its exterior, he mounted the log on the lathe centers and ran a truing cut over it; then carrying the log in several homemade beech steady-rests, he bored the barrel with a "hog-nosed" drill.

Machine tools have changed vastly since those days, but men are still men. If the old workmen could return, they would soon be able to do good work with modern appliances. If obliged to employ the tools and methods of a century ago, we should find more difficulty, but if we are real machinists, not mere runners of machines, we should soon learn to do as our fathers did, for, in spite of what some people say, the skilled eye, hand and brain are of far more importance to good work than any machine, invaluable as the improved machine is, and indispensable to rapid work.

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* * *

At the suggestion of the War Department, the manufacturers are now trying to make the parts of motorcycles for use in war as completely interchangeable as possible. The War Department desires large numbers of motorcycles for dispatch work and transportation of machine guns, an official of the motorcycle engineers explained. The department has suggested to the engineers that ultimately the United States will have one standard war motorcycle and also one standard truck.

PRODUCTION OF ACCURATE THREAD GAGES

METHODS USED IN MAKING THREAD-CUTTING AND RADIUS-FORMING TOOLS AND ANGLE-GRINDING FIXTURE

BY J. R. MACINTYRE[1]

THIS article has been written because little has been published on the actual making of thread gages, though most publications intended for toolmakers and machinists have published formulas from time to time, for measuring and inspecting these gages. Undoubtedly many firms are producing accurate thread gages both quickly and efficiently, but the average tool- and gage-maker has still to learn how this work is done.

The most varied experience on thread gages, aside from working for one of the firms that manufacture them is to be had in the arms and ammunition plants that are making rifles for the different foreign governments. The production and inspection of the modern military rifle requires many sizes and forms of thread gages. Some of the thread angles and elements are strange to the American-trained toolmaker, for instance the Loewenherz thread, which has an angle of 53 degrees, 8 minutes, and the French and Russian metric threads, which are rounded at the bottom of the thread in the screw, and at the top in the nut.

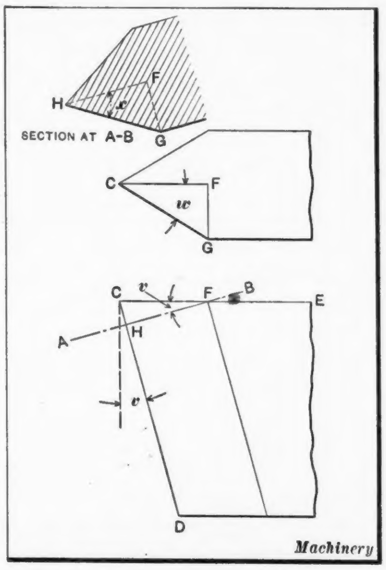

Fig. 1. Diagram for calculating Angle of Thread-cutting Tool

It is seldom that any two tool-rooms approach the problem of thread-gage production in exactly the same manner. Some plants mill their thread gages, while others cut them in either a bench or an engine lathe; and after hardening, some prefer to grind and lap the gages, while others finish them to size by lapping only. The success of thread-gage making depends, as does all other accurate work, on a thorough understanding of the requirements, machine equipment, personal element, raw materials, and so forth; but unless the work is started along the proper lines and these lines are strictly adhered to, the gages will meet neither the expectations nor the inspection limits.

The tools and devices here described are representative of the current practice in the thread-gage department of the Remington Arms Co., Bridgeport, Conn., where thread gages of the various types for gaging rifle parts have been satisfactorily produced. The writer's part of the job was the origination and production of the various angle-testing bars, radius bars, grinding fixtures, thread tools, wires, laps, etc., the calculation of micrometer readings over wires for threads of any angles, change-gears for metric and special threads, and work of

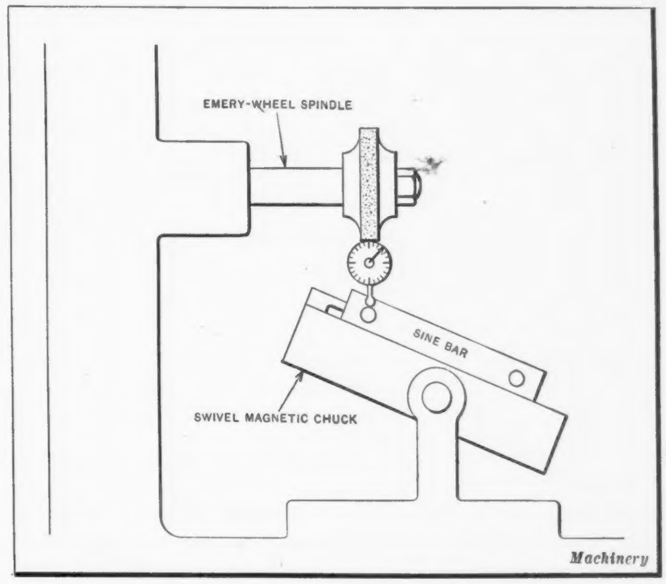

Fig. 3. Diagram for calculating Angle of Magnetic Chuck

a similar nature. In the production of the necessary tools, etc., the first thing required was the origination of a master single-pointed thread tool, Pratt & Whitney style, for each particular type and pitch of thread gage. For example, in the case of the French 60-degree thread gage with round top and root of thread, one tool was made for each radius; similar gages were required for the 53-degree thread gages with rounded top and root, and so on. Simultaneously with the different steps in the making of the master tool, and often preceding some of the steps, came the origination of the necessary fixtures or test-bars for making the tool.

The thread-tool blanks are cheaper to buy than to manufacture, if one is not engaged in gage-making as the principal business. When one considers the long life of these types of thread tools, which only need grinding on the top to restore them to first-class condition, it is evident that the blanks should be seasoned as thoroughly as possible, but as time is at a premium at present, the blanks are often finished while in a state of molecular strain, which tends to add to the somewhat inherent instability of such tools.

Some attempt should be made to so plan the work that, after each operation on the thread tool, some other part of the job can be taken up, so as to give the tool some chance to relieve itself of the strain caused by machining. When the tool is being ground, there is a great danger of overheating the thin edge, causing it to be too soft; a soft, coarse wheel with light cuts will give a good finish that will not need much lapping, and at the same time reduces the chance of overheating the edge.

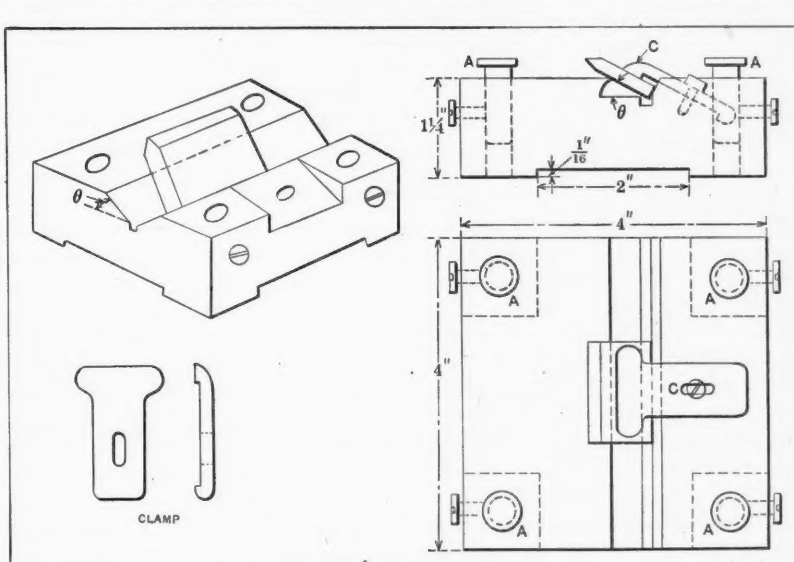

Fig. 2. Angle-grinding Fixture

Fixture for Grinding Thread Angle on Tool

When making the fixture for grinding the thread angle on the tool, it must be borne in mind that the angle ground on the thread tool in a plane at right angles to the

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sharp edge of the tool is greater than the angle that will be cut on the gage by the tool. The excess amount is dependent on the amount of front clearance of the tool; 15 degrees is universally accepted as the most efficient clearance angle.

The method of calculating the angle of the thread tool is as follows: Let the clearance angle be v, and half the actual thread angle, w, as shown in Fig. 1. The thread-tool angle, which is greater than the actual thread angle, is measured at right angles to line CD, or in the plane AB. Angle w is measured in plane CE. Angles v and w are known. The angle in plane AB that is to be found is called x. This is half the included angle, corresponding to angle w. Then, referring to Fig. 1,

$$CF \cos v = FH$$
$$CF \tan w = FG$$

Hence,

$$\frac{FG}{FH} = \tan x = \frac{\tan w}{\cos v}$$

For a 60-degree U. S. thread:

$$\text{Tan } x = \frac{\tan 30 \text{ deg.}}{\cos 15 \text{ deg.}} = 0.597748$$

$$x = 30 \text{ degrees } 52 \text{ minutes } 6 \text{ seconds}$$

If this angle is multiplied by 2, the answer will be the required angle on the thread tool in a plane at right angles to the thin edge of the tool; hence 2 × 30 degrees, 52 minutes, 6 seconds = 61 degrees, 44 minutes, 12 seconds, the required angle.

This angle, of course, is different for every class of thread. For a Whitworth 55-degree thread it would be:

$$\text{Tan } x = \frac{\tan 27 \text{ deg. } 30 \text{ min.}}{\cos 15 \text{ deg.}} = 0.538946$$

x = 28 degrees 19 minutes 20 seconds, or the full angle, 56 degrees 38 minutes 40 seconds

It will be plainly seen from the foregoing calculations that the angle to which to grind the thread-tool fixture will be 30 degrees, 52 minutes, 6 seconds for a 60-degree thread angle. The fixture is shown in Fig. 2. The block is made of machine steel and pack-hardened; the approximate dimensions are given. The base is cut away so as to allow the block to rest on the four corners. First the block is shaped all over and the angles shaped out, with clearance groove, as shown, so that when the angles are ground, there will be enough clearance for the grinding wheel to cut right across the angle. The slot for the tool-holding clamp C is also shaped out; then the four ⅜-inch holes for the round lapping pins A are drilled,

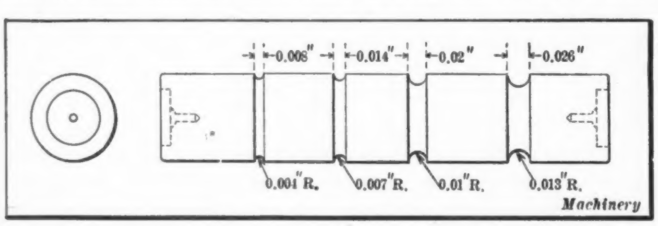


Fig. 4. Master Bar for testing Radius on Point of Thread Tools

also the four small screw-holes for clamping the lapping pins in position and likewise the screw-hole for the tool clamp.

The fixture, after hardening, is ground square and flat all over and, in this instance, is put on a Walker surface grinder that is equipped with a universal swiveling magnetic chuck. A sine bar is held on the face of the chuck by the current, and a dial indicator is held between clamping washers on the wheel-spindle; the chuck is then swiveled until the correct angle is obtained, as shown in Fig. 3. As a 5-inch sine bar is used, angle θ = 30 degrees, 52 minutes, 6¼ seconds and $X = 5 \times \sin \theta = 5 \times 0.51307 = 2.56535$ inches. By the use of the micrometer readings on the elevating-screw handwheel and the dial indicator, the difference in height of the two buttons is set to 2.56535 inches, which is the correct angle.

The fixture is now placed upon the chuck and ground on angle θ, and as the surface that the back of the thread tool rests against is at an angle of 90 degrees to the surface just ground, it can also be ground without moving the fixture. The four ⅜-inch holes are then ground, so that they will be perpendicular to the base of the block, in order that the pins, Fig. 2, will not cant out of the vertical line when they are moved up or down, and thus require much grinding to bring all four tops into the same horizontal plane again, this plane being, of course, parallel to the base of the block.

Master Radius Bar and Radius-forming Tool

Upon the completion of the grinding fixture, the master radius bar should be made. This bar is provided with semicircular grooves in the circumference, one groove for each radius required by the respective thread tools for the different pitches of threads; that is, the fine-pitched threads require thread tools with small radius on the point of the tool, whereas the tools for cutting coarser threads will have a larger radius on the point. The bar is made of medium-hard brass, softness not being any detriment to this tool, as it is only used for reference, while the peculiar construction and frailness of the radius-forming tool precludes the use of any hard, tough metal. The bar is made from stock 0.75 inch in diameter and 5 inches long. This bar is centered and placed between centers in a "Pierce" bench lathe, which has a handy vertical slide for adjusting the cutting tools to the exact height of the centers; then the bar is trued up until it is circular.

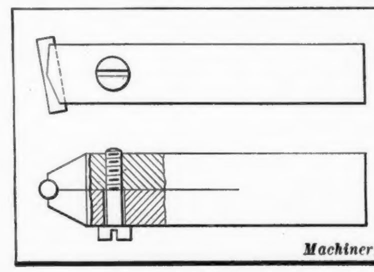


Fig. 5. Radius-forming Tool

At this point there should be constructed the radius-forming tool, similar to that shown in Fig. 5. This tool is made of a piece of 5/16-inch square medium-hard brass; its length is about 3 inches, to suit the toolpost. Assuming that the radius to be cut is 0.009 inch, a hole 0.018 inch in diameter is drilled, with a needle drill, at an angle from the vertical that will provide just enough clearance for the tool to cut and not rub. If this angle of clearance is too great it will alter the size of the radius cut by the tool. A tapped clearance hole is drilled in the side to take the small screw necessary for clamping the round radius tool in position; also a slot is cut in the tool to a depth of, say, ¾ inch. The actual cutting tool is a piece of sewing needle of suitable size that has been lapped truly circular and down to 0.018 inch in diameter.

To cut the grooves in the master radius bar, assuming the desired radius to be 0.009 inch, the bar is held between dead centers, that is to say, the headstock spindle is not revolved, and the radius-forming tool is fastened in the toolpost with the top of the radius tool at exactly the height of the lathe centers. The radius tool is then fed in by the cross-slide screw until it is seen, by the aid of a strong magnifying lens, to just touch the radius bar. The radius bar is then revolved by the finger and thumb of the left hand and the radius tool is fed in exactly 0.009 inch, by the micrometer dial on the cross-feed screw. The bar is then the master female radius gage for testing the male master thread by a "light" test.

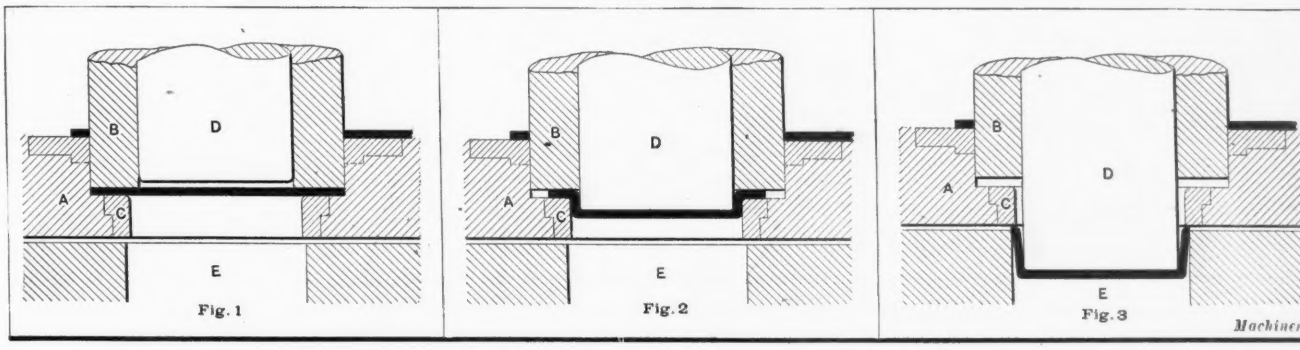
After the master thread tool has been ground and lapped in the angle-grinding and lapping fixture shown in Fig. 2, it is ready to have the radius lapped to size. When the thread tool is mounted in the holder and fastened in the toolpost with the ground top of the tool at the exact center height, the radius should shut out light when the tool is fed carefully into the master radius test-bar and a strong light is coming from underneath.

A master thread tool with a female radius groove is made from the master male radius thread tool and then hardened; with these two tools, master taps and master reference thread gages are made. The master taps are used to make cast-iron laps for finish-lapping the hardened working and inspection thread gages. The master reference thread gages should be left soft; of course, a number of working thread tools must be made along the same lines as the master thread tools, both male and female, to be used in the production of thread gages, as the master male and female thread tools are used only to make the necessary tools and master gages for making and testing the thread tools used to make the thread gages.

CARDBOARD FORMING

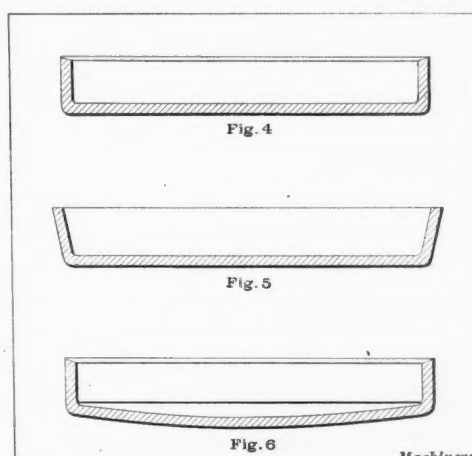
ARRANGEMENTS FOR MOISTENING STOCK, HEATING DIES, AND DRYING PRODUCT—FORCES AT WORK DURING FORMING STROKE

BY R. A. MONTE[1]



Figs. 1 to 3. Blanking and Forming Dies for Double-acting Punch Press, showing Sequence of Operations

THE forming or pressing of cardboard covers, lids or odd shapes is based on the same principles as the drawing of shallow sheet-metal boxes or covers, and the process differs only in such special treatment as is necessitated by the peculiarities of the material. Figs. 1 to 3 illustrate the customary construction and sequence of the blanking and forming dies used in connection with a double-acting punch press. The bolster *A* is screwed down to the press table, or platen, and the outer blanking plunger *B*, actuated by a cam, descends and cuts through the cardboard stock at about 3/10 to 1/2 of its travel. This plunger stops at a height equal to the thickness of the stock, above the face of the drawing die *C*, and dwells there for about one-eighth turn. The inner plunger *D*, driven by a crank or eccentric, is timed to reach the blank soon after the outer plunger *B* has reached its lowest position and draws the rim over the rounded edge of die *C*, converting it into a smooth, solid rim. By descending farther, plunger *D* pushes the finished lid through drawing die *C* into the drying tube *E*, which is slightly larger in diameter than die *C*. As the compressed cardboard rim is still under high tension, it expands until it fills out the larger diameter; this causes it to be stripped from plunger *D*. The blanking and forming dies are hardened, and the drawing die is polished.



Figs. 4 to 6. Cardboard Covers correctly and incorrectly heated and moistened

Moistening Stock

Cardboard varies widely in quality, and its action in being cut, drawn and formed into commercial shapes naturally depends on the nature of the material. It includes the coarse, brittle stock used for milk-bottle caps, which has a resistance to shear of only 35 pounds per linear inch, and tough fiber boards that have a shearing resistance of 200 pounds per linear inch. Thin strawboard may be formed into small shallow boxes or lids without any additions to the dies just described, if there is no objection to a crinkled rim with quite visible folds. A smooth, stiff rim, however, invariably requires the application of moisture, heat and pressure in due proportion and timing; any variation from the experimentally established degrees of moisture, temperature, etc., will affect the final shape of the article.

Fig. 4 shows the shape of a lid that has been correctly moistened and heated for the proper amount of time. Fig. 5 shows a similar lid which was not heated and dried sufficiently; in this case the lid flares. Fig. 6 shows either excess or one-sided moisture, the bottom being too wet on the lower side to dry in the same time as the rim and inside. Each shape and grade of stock must be investigated and treated individually.

For some of the thinner grades of cardboard, the correct degree of moisture can be obtained by simply storing the stock for twenty-four hours in a damp place like a basement. Thicker stock can sometimes be sufficiently moistened by being placed in a pail of water and letting the excess moisture drip off shortly before the cardboard is used. Some manufacturers add starch, dextrine, or other paste stuffs, soapsuds, rosin, etc., to the water.

Fig. 7 represents a combined roll feed and moistening device. Several brass rolls geared to each other carry the water up to the lower surface of the stock. By this arrangement, the lower surface gets an excess of moisture; this is necessary because it is more exposed to the heat of the die than the upper and inner surfaces. Some grades of stock get sufficient moisture by simply being run over the water rolls as shown; others must be run one or more times around the water rolls, thus being fully submerged and thoroughly soaked.

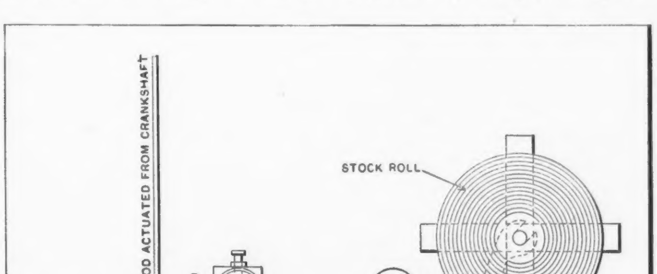


Fig. 7. Roll Feed and Moistening Device

It is very desirable to use stock cut to the proper width. If warranted by the amount of work on hand, the stock roll shown in Fig. 7 should be used, but small orders should be run in the form of strips cut from standard size cardboard sheets. The roll feed, as shown, is operated from the press crankshaft through a small crankpin or eccentric acting on the ratchet on lever *F*. If the stock cannot be obtained in the form of rolls and ordinary card-

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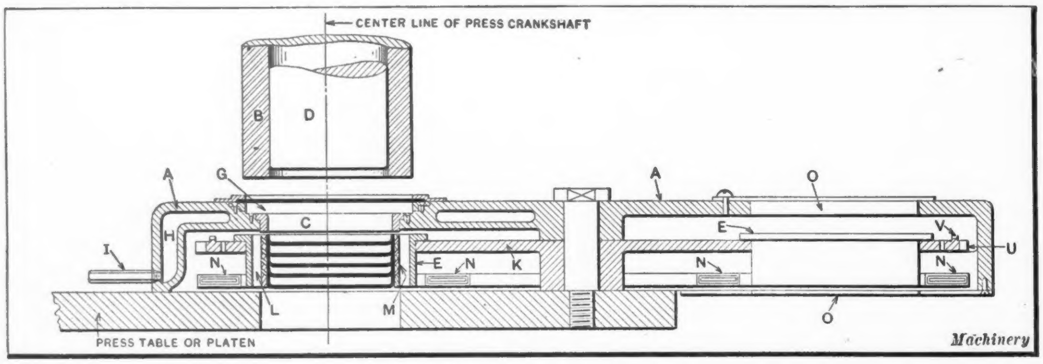

Fig. 8. Sectional View of Drying Table

board sheets must be used, it is more economical to feed these sheets or strips by hand than to attempt to devise a stack feeder. Stack feeders are complicated and costly, and the small increase in output is more than offset by the delays caused through trouble with the stacker. Although the speed of these presses is rather low, about 25 revolutions per minute, it is not advisable to have one operator attend to more than one press, as the product needs constant watching.

Heating and Drying Arrangements

If the steaming moist lid were ejected as it left the die (see Fig. 3), it would not retain its shape; hence a heated drying table is necessary for evaporating the excess moisture and permitting the glue stuffs in the cardboard pulp to obtain a

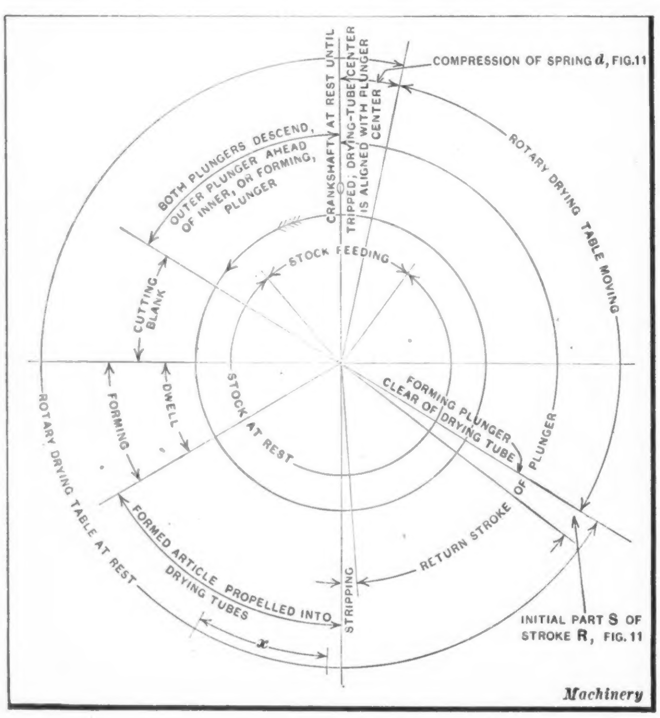

Fig. 9. Timing Circle for Average Type of Punch Press

permanent set. Figs. 8 and 11 show the construction of the drying table used in connection with the blanking and forming dies. Fig. 8 is a section on X–X, Fig. 11; *B* and *D* represent the double-acting plungers, *G*, the blanking die, and *C*, the forming die. The steam-heated bolster *A* has cored cavities *H* all around the forming die; the exhaust or other low-pressure steam used enters the cavities at *I* and the condensed water is piped away at *J*.

The rotary drying table *K* carries a series of drying tubes *E*, in which vent holes *L* and *M* are provided for the egress of pent-up air and vapor given off by the steaming surfaces. These tubes are made of cast iron, the inside, of course, being smooth and highly polished. Electric heaters *N* supply heat for the drying tubes *E*. If steam coils were used instead of electric heaters, live steam would be required to transmit a sufficient amount of heat; besides, such coils are prone to leak, and leakage would seriously affect the product. The electric heater, because of its ease of installation and the close regulation that is possible, is superior in every respect.

As shown, the lids are allowed to pile on top of one another in the drying tubes *E* and are carried around several times before being ejected by the plungers. It is preferable to use as many drying tubes as the available space between the press uprights will permit; that is, not more than four or five pieces should be piled on top of one another in the tubes. Cardboard, 1/8 inch thick, that was thoroughly saturated has come out bone dry when piled four high in presses with sixteen drying tubes on the circumference of the drying table. The openings *O* in the top and bottom of the bolster are provided merely for inspecting the work.

The intermittent movement of the table is procured as follows: A reciprocating slide *P*, carrying a pawl *Q*, is guided in a groove in the bolster and confined by the guide cover *T*. Its stroke *R* is the distance between the teeth *U* on the periphery of the drying table *K*, plus an excess *S*. A leaf spring inside pawl *Q* holds it in engagement with teeth *U*; the extension *W* limits the movement of the pawl for correct engagement with teeth *U*. These teeth need not be machined very accurately, but the stops *V* on top of the drying table, which stop the table when the tubes are exactly under the plunger, must be closely adjusted for each drying tube. The spacing of drying tubes *E*, within certain limits, is not very important; the only point needing close attention is the relation of stop *V* to its tube. The stop can be easily adjusted when setting up the table, by inserting the inner plunger, consecutively, into each drying tube *E*, and trimming the stop until pawl *Y* falls into position without any backlash. Stops *V* should be of hardened tool steel and securely screwed and doweled into position.

The stop-pawl *Y* should be of hardened tool steel and securely pinned to bolster *A* so as to have no backlash. The pin should be of ample size and bearing to prevent wear. Any inaccuracy at this point, if more than, say, 1/32 inch, is likely to throw the plunger and the drying table out of register and result in breaking the bolster, die and table. Pawl *Y* carries at its end a pin *Z* that is engaged by tappet *a* on slide *P* during the first part *S* of the stroke *R*. This tappet lifts the pawl *Y* out of mesh with stop *V* before pawl *Q* reaches tooth *U*. As pawl *Q* runs up hard against pawl *Y* when it is stopped by the next stop *V*, a spring take-up is inserted at the driving end of slide *P*. This consists of a link *b* containing a plunger *c* and a spring *d*. The lever *e*

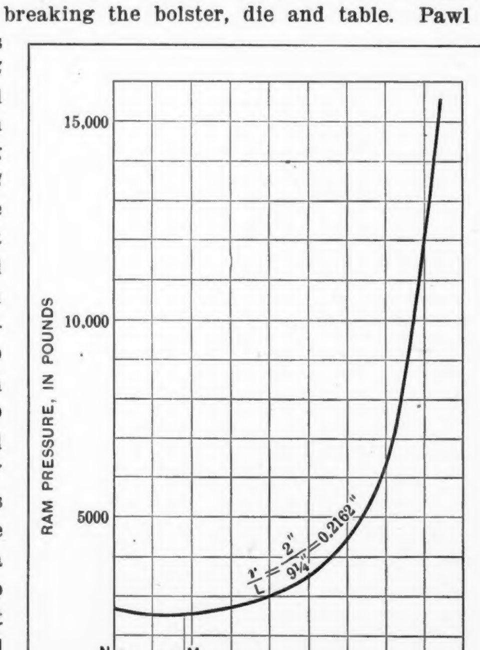

Fig. 10. Force exerted by Inner Plunger while forming

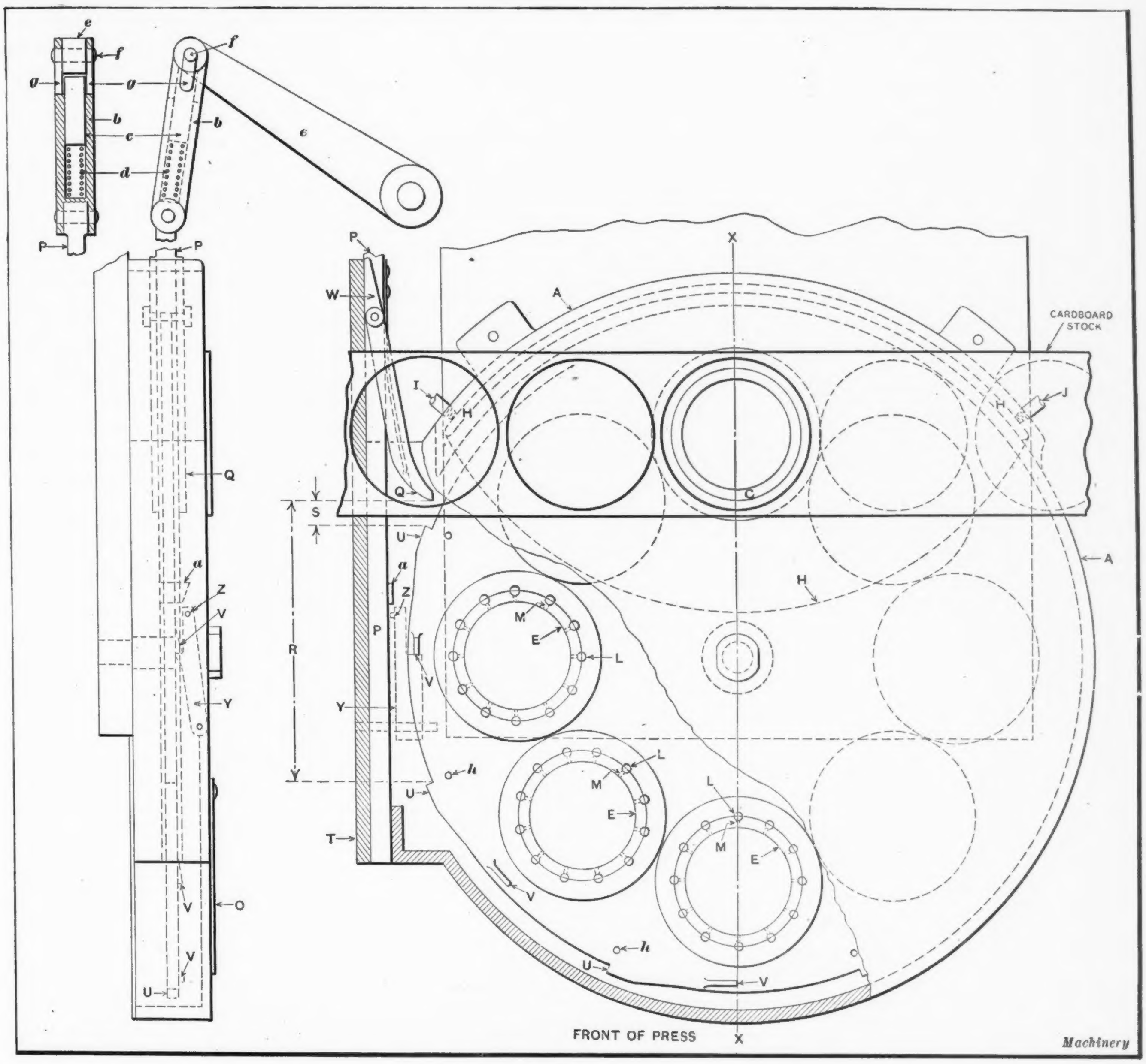

Fig. 11. Plan of Drying Table shown in Fig. 8

is confined by pin *f* to the length of slot *g*, so that at the end of the stroke spring *d* yields, permitting lever *e* to run its full course. Lever *e* is customarily driven by a plain face cam (not shown), which is properly timed to produce the intermittent table motion, while the plunger is clear of the drying table.

Drying Table Safety Device

While spring *d* must be strong enough to overcome the frictional resistance of the table, which, by the way, is very small, the spring cannot be made strong enough to overcome jams produced by pieces of cardboard getting wedged in between the table and the die. Such occurrences invariably produce two

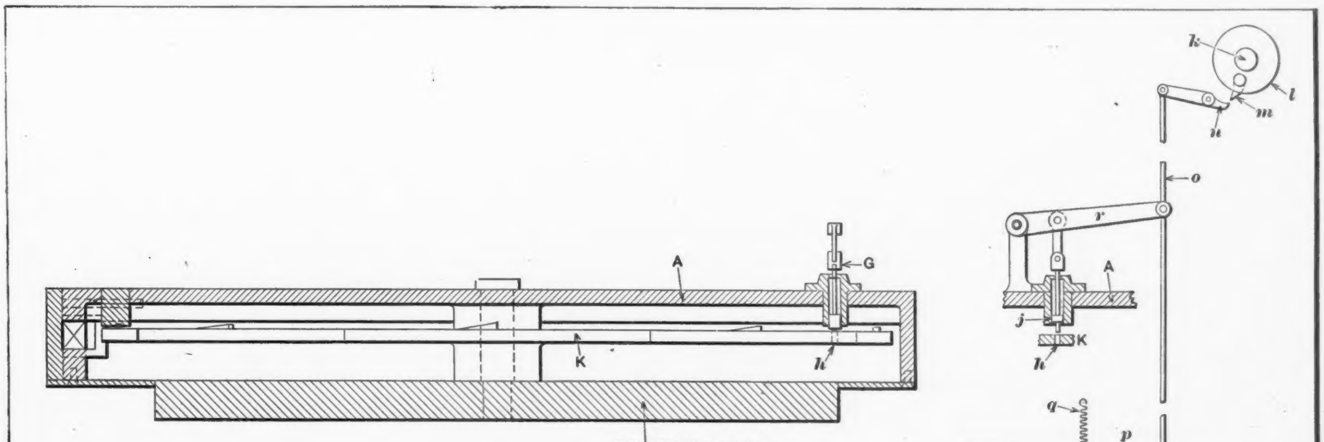

Fig. 12. Safety Catch to prevent Plunger from hitting Table

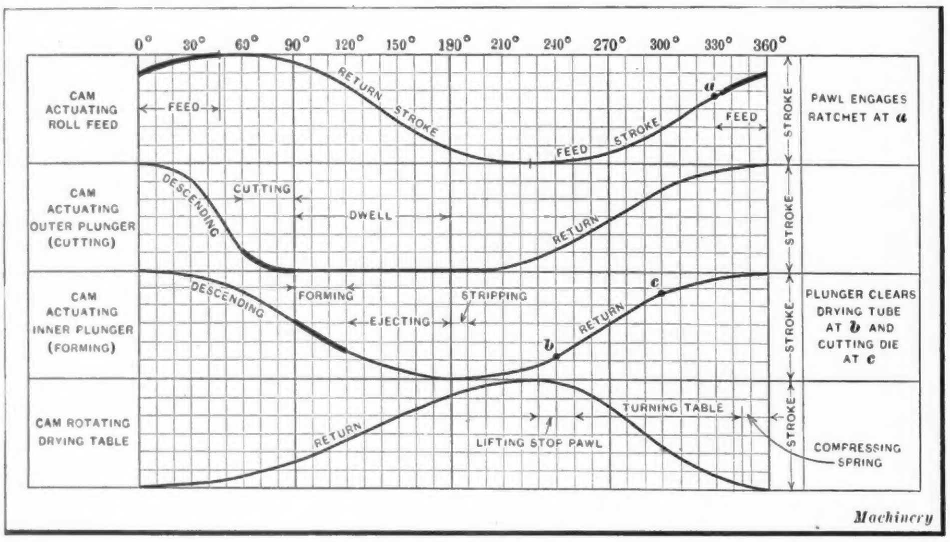

Fig. 13. Cam and Crank Timing Chart

kinds of damage. In one case, the weakest parts of the slide movement give way; in the other, the descending plunger hits the table, instead of registering with a drying tube, and smashes it. The danger of breakage from this cause is over-

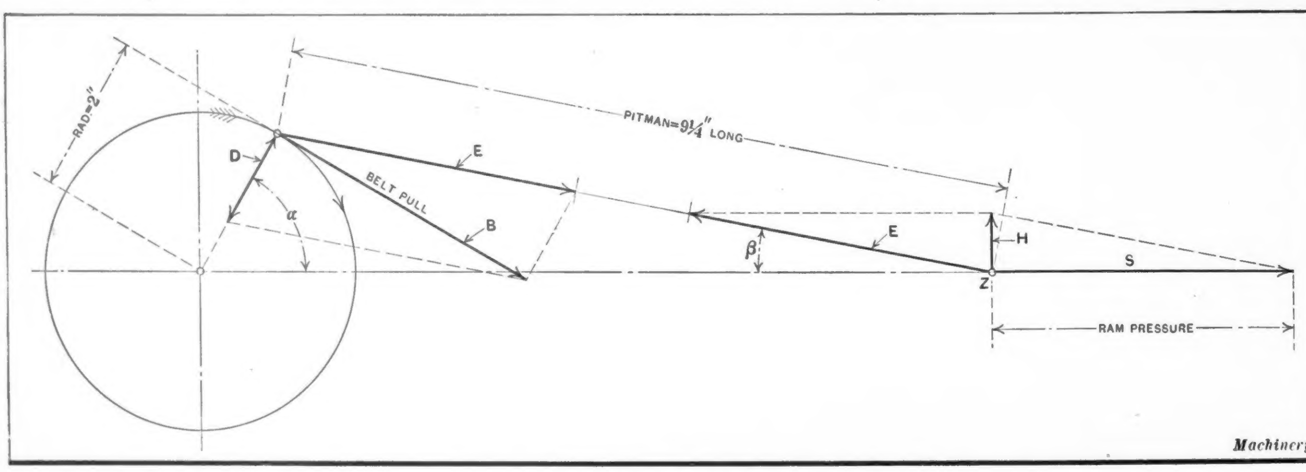

Fig. 14. Analysis of Belt Pull

come by the simple safety device shown in Fig. 12. The drying table has a series of accurately located holes *h*, Fig. 11, exactly midway between each two tubes *E*. The safety-catch pin *j* rides on table *K* on the exact circle of centers of holes *h* and is free to drop into the holes. If everything is perfectly adjusted and in register, pin *j* comes in alignment with a hole *h* and drops into it at the end of each stroke. If for any reason the table gets jammed out of alignment at the end of stroke *R*, Fig. 11, pin *j* will not be aligned with a hole and therefore will stay up. It will hold the clutch *l*, Fig. 12, out of engagement and will prevent the plunger from descending; in other words, it will stop the action of the press and prevent a smash-up.

This safety catch is operated by a treadle as follows: The flywheel-pulley crankshaft *k* carries a clutch *l*, which is thrown into action when dog *m* strikes stop *n* of the safety catch; the crankshaft then revolves and the plungers descend. A rod *o* connects the stop-lever *n* with the treadle *p*, which is held up by a spring *q*, thus stopping the press automatically after each revolution. If for any reason there is no hole *h* in alignment with pin *j*, the operator cannot depress the treadle, and consequently cannot trip the press until the trouble has been located and attended to. Obviously, with this arrangement, the operator must be instructed to keep his foot off the treadle; that is, he must trip the press for each stroke and not keep his foot on the treadle all the time. However, little trouble is experienced from this one weak point of the safety device.

Determination of Forces at Work during Forming Stroke

The cam and timing diagrams, Figs. 9 and 13, are self-explanatory. The lay-out shown in Fig. 9 is for any standard make of punch press; with a specially designed press, cutting and forming should be done at *x*—at the bottom of the stroke.

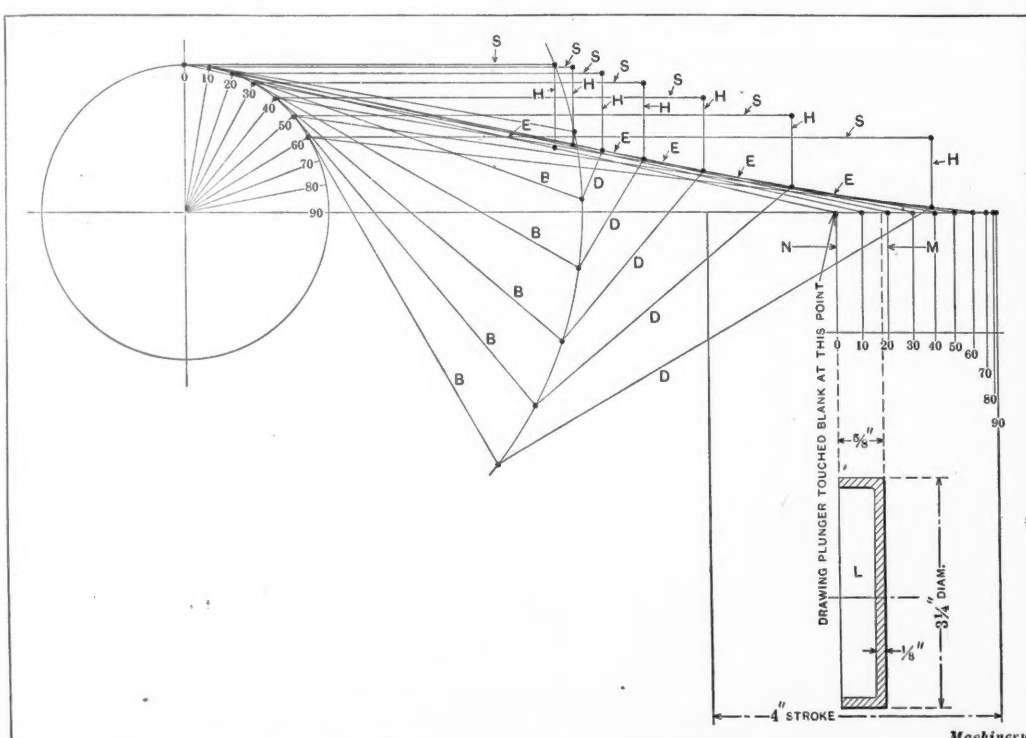

Fig. 15. Available Ram Pressure of Forming Plunger

Figs. 10, 14 and 15 illustrate a method of determining approximately the forces at work during the forming stroke. The article being produced is a fiber board lid L, Fig. 15, about $3\frac{1}{4}$ inches in diameter and $\frac{5}{8}$ inch high; the stock is $\frac{1}{8}$ inch thick. The double-acting press has a stroke of 4 inches, and is set to start forming at the middle of the down stroke. The press runs at 25 revolutions per minute and has a 35-inch flywheel pulley, 270 pounds rim weight, and a double belt $4\frac{1}{2}$ inches wide. This press was rather weak for this job, so the belt was tightened to its utmost capacity; then the belt pull, when measured, was found to be 300 pounds, or about 66 pounds per inch belt. This produces a torque of

$$\frac{300 \times 17\frac{1}{2}}{2} = 2625$$ pounds at the crankpin radius.

In Fig. 14 this belt pull is resolved into the crank-arm pressure and the pitman thrust. The latter, at Z, is resolved into the wrist-pin guide pressure and the ram pressure. Fig. 15 shows the same scheme as a composite diagram of the ram pressures exerted during the forming part of the down stroke. Here B represents the torques at different crank-pin radii, due to belt pull, for various crank-angles; D, the corresponding crank-arm pressures; E, the pitman pressures; H, the wrist-pin strains; and S, the ram pressures exerted at the various angles as analyzed.

In Fig. 10, the available ram pressures thus found are plotted as ordinates, with crank-angles as abscissas, for the ratio of crank-radius to pitman length of the particular case under investigation. The forming pressure in this case must have been around 2500 pounds, as shown at NM, Figs. 10 and 15.

As already stated, the ordinary run of punch presses of standard make are little suited for the special requirements of this work. The press tables are too close to the ram and do not give sufficient height for a properly proportioned drying table. When the amount of work on hand warrants the expenditure, a press especially designed for each individual case is strongly recommended. The economy in power and in wear and tear will amply repay the trouble of properly proportioning the parts involved.

* * *

TRADE SCHOOLS IN THE PENNSYLVANIA EASTERN STATE PENITENTIARY

BY B 8128

About a year ago Warden Robert J. McKenty of the Eastern State Penitentiary, Pennsylvania, had his attention called to the engineering extension courses conducted jointly by the Pennsylvania State College and the Y. M. C. A. As he had long recognized that one of the main contributing causes to criminal delinquency is the lack of a proper trade training, he arranged with the State College, which for years had been conducting an agricultural correspondence course in the prison, to form a class in which the principles of mathematics and mechanical drawing would be taught. Machine shops, woodworking shops, etc., have long been a feature of the most advanced penal institutions, but, as far as the writer knows, the Eastern State Penitentiary is the first to apply successfully the principle of the continuation school.

The first two classes, with an enrollment of thirty-five men, were started by an instructor furnished by the State College and the Y. M. C. A. in May, 1916. At present the entire instruction is given by an inmate, who has the necessary training to qualify him for the work and who has won the unqualified approval of the State College; a State College supervisor, however, visits the institution weekly. But this was only the beginning. As soon as the men realized how the instruction would benefit them, they were not satisfied until the scope of the undertaking was enlarged. The courses embrace interesting and practical lessons in mathematics and mechanical drawing, as used daily in the shop. The fundamental principles are taught, familiar terms and processes being used and numerous applications to shop problems being given, so as to develop in the student the ability to apply the mathematical and scientific principles in his everyday work. For those who have finished this course, instruction in advanced shop mathematics is provided, as much of algebra, geometry, trigonometry and logarithms being taught as has been found to be of practical value in the shop.

There are now two courses in mechanical drawing. The elementary course is intended to develop in the student the ability to read blueprints and to make drawings and sketches of simple objects. The men are given isometric sketches which they work up to finished mechanical drawings in their cells. This has proved of great value in developing the power of visualization. The advanced course has been developed for men who wish to acquire a good working knowledge of drawing, as practiced in the best drafting-rooms. The text and the problems have been carefully prepared and arranged so as to develop speed, accuracy and neatness.

A large number of men employed at present in the woodworking and machine shops of the institution, who were competent mechanics when they entered, are taking up these courses and are thus fitting themselves for positions of responsibility as toolmakers and foremen. They realize that every man pays for the supervision he requires, and that that supervision represents the supplying by superiors of the knowledge that the untrained man lacks. Others who are classified in the admittance records as unskilled laborers are enrolled in the electrical and the plumbing schools, where they are taught the rudiments of the trades. The apprentices of the electrical school receive practical training by assisting skilled mechanics in the installation and the repair of the elaborate electrical equipment of the penitentiary. The plumbing apprentices work daily with a master plumber, looking after a large plumbing system. Each of the cells (and there are nearly a thousand) is supplied with a self-flushing toilet, running water, and a steam radiator, so that there is ample opportunity to learn every branch of the trade.

The inmates employed in the large power plant of the prison, with its three high-speed automatic engines, direct-connected to 50-kilowatt generators, are instructed in the use and application of the indicator, valve setting, and the care of the numerous boiler auxiliaries. A 25-ton refrigerating machine is also under their care. The men in the boiler room have an equipment of five horizontal return tubular 100-H.P. boilers and are instructed in the theory and practice of boiler-room economy, so that upon their release they may obtain licenses as first-class firemen.

But the thing that counts most in all these efforts to make the trade school a success is the personal element. Without the continual encouragement and interest that the warden shows in his daily intercourse with the inmates, it is doubtful if such excellent results could be obtained.

* * *

Truck manufacturers and users generally advocate the use of solid rubber tires, but evidence shows that the pneumatic tire, properly proportioned to the load, is as advantageous for trucks as for pleasure motor vehicles. The test on a Packard $1\frac{1}{2}$-ton army transport truck was recently made over a distance of 4288 miles from Detroit, Mich., to the Mexican border and back. The truck was fitted with 36- by 7-inch "Nobby" tread U. S. pneumatic tires. The conclusions drawn from the trip are that an average of 40 per cent more mileage per gallon of gasoline can be obtained from trucks equipped with pneumatic tires than from those equipped with solid tires, and that oil consumption is reduced 25 to 30 per cent. The pneumatic tires greatly reduce road shock and lower truck depreciation fully 50 per cent. The average mileage per gallon of gasoline was seven, and the lubricating oil consumption of the trip was one quart of oil per 33.42 miles.

* * *

A movement has been initiated by the Association of British Machine Tool Makers for a greater degree of specialization among machine tool builders. According to the *Yorkshire Post*, some of the firms have arranged among themselves that each shall devote itself to the production of a single type of machine. This policy permits of the production of machine tools being placed upon a manufacturing instead of a "jobbing order" basis. It also lends itself to the appointment of group publicity agents and travelers, both at home and abroad.

AUTOMOBILE SPRINGS

NOTES ON PRINCIPAL TYPES, MANUFACTURE AND TESTING

BY CHESTER L. LUCAS [1]

THE use of leaf springs for horse-drawn vehicles dates back to 1750, but it remained for the motor car industry to put the manufacture of vehicle springs upon a scientific basis. A great deal of credit for this advance is due the Springs Division of the Society of Automobile Engineers, who, of course, have received the cooperation of American spring manufacturers.

Fig. 1 shows the five most important types of automobile springs in common use, though there are many variations in forming and mounting. These are the full elliptic, semi-elliptic three-quarter elliptic, cantilever, and platform types. Each type has an action different from the others and is used in various front and rear combinations by different automobile builders, the practice varying with the demands of the particular car in question.

Full Elliptic—This type of spring is probably the most flexible of the standard types, but it is more susceptible to side sway than the other springs. Its easy-riding qualities give it popularity when installed under proper conditions. It is often made with one or both ends in scroll form. A good example of its use is found on the Franklin car.

Semi-elliptic—This spring is not as flexible as the full elliptic, nor is there as much tendency toward side sway. It is more largely used in both front and rear installations than any other type of spring. Among the most common of the cars using it are the Pierce-Arrow and the Chalmers.

Three-quarter Elliptic—This type is a compromise design that is more flexible than the semi-elliptic and still has the side sway well controlled. Almost invariably, this spring has a scroll member at the top, but at times it is used without the scroll. This is a popular spring for rear installations in combination with the semi-elliptic at the front. Among the cars using this type of spring are the Dodge, Studebaker and Oldsmobile.

Cantilever—The cantilever spring is growing in popularity, particularly for rear installations. It permits little side sway, and the action is quite different from that of the regulation elliptic type. It is, in reality, a semi-elliptic spring mounted in cantilever form. On account of the method of mounting the cantilever spring makes the frame take a part of the spring action. It is used as a rear spring, in combination with the semi-elliptic at the front, on the Buick, Briscoe, King, and other cars.

Platform—The platform type of spring is used altogether as a rear spring and is very flexible. The action is much the same as the three-quarter elliptic, due to the fact that a quarter elliptic member is set at right angles to the semi-elliptic member, instead of in line with it, as in the regulation three-quarter elliptic. Good examples of the use of platform springs as rear installations may be found in the Packard and Cadillac cars.

A glance at Fig. 1 will show that the semi-elliptic spring member is the basis of all types of automobile leaf springs. Fig. 2 shows two types of semi-elliptic spring members, the upper of which is designated as the "true sweep," while the lower is the "double sweep" type. Of these types, the true sweep spring has by far the better action, as there is less friction in the movement between the leaves of the spring. The double sweep spring is heavier in proportion than the true sweep spring, and its use is confined principally to commercial vehicles.

The average length of a front spring for pleasure-cars is forty inches, and for the rear spring, about fifty inches; but, of course, this varies for different weights of cars. The opening of a semi-elliptic spring, or the distance from a line through the eyes to the center of the inside arc of the spring, is from five to six and one-half inches. The leaves are usually

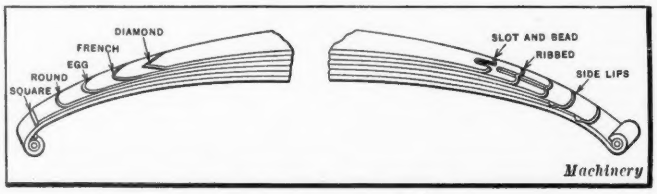

Fig. 3. Varieties of Spring Plate Ends in Common Use

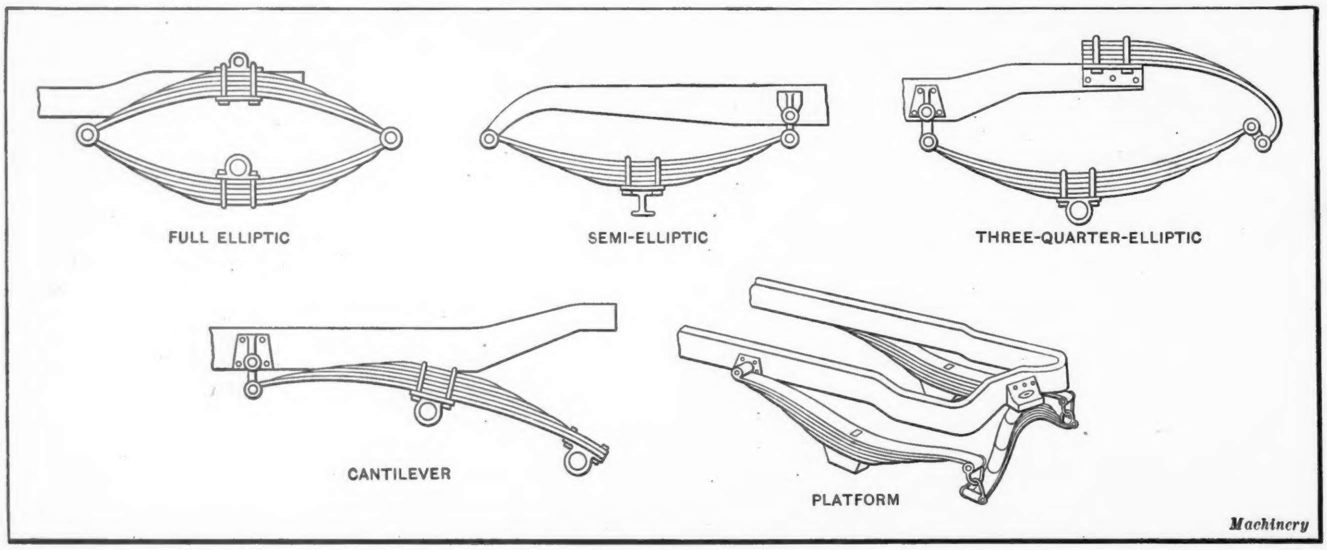

Fig. 1. Principal Types of Automobile Springs

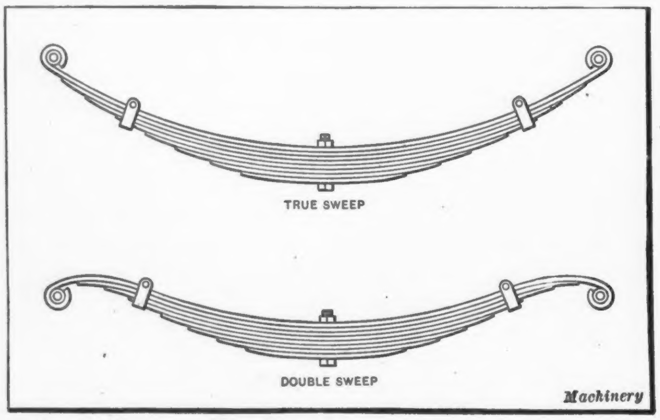

Fig. 2. General Arrangement of Spring Plates, Clips, etc., in True and Double Sweep Springs

[1] Associate Editor of MACHINERY.

two inches in width, and the number of leaves in the spring varies with the load it must carry; there are generally from six to ten. The larger the number of leaves and the thinner they are, the greater is the flexibility of the spring. The application of this principle is, of course, limited by the impracticability of making springs with extremely thin leaves. The number of leaves and their thickness are points that are usually left to the spring manufacturer.

Detail of Spring Leaves

The first leaf of the spring is called the "master" leaf or "back" plate; the next leaf is the "long" plate; and the shortest leaf is the "short" plate. The usual length of the short plate is three-tenths the length of the back plate, and the spacing is evenly graduated from the short plate to the back plate. In an eight-plate spring, the spacing of the leaves is about 2¾ inches. No. 2 gage steel is most commonly used for the heaviest or back plate of the spring. There are two schools of spring-makers; one advocates that all the leaves of a spring should be of the same thickness; the other favors decreasing the thickness of leaves from a heavy back plate to a thin short plate.

The leaves of the spring are held together with a 5/16-inch bolt at the center; besides, at each end of one of the plates about a third of the way from the eye to the center "rebound clips" are riveted. These clips reach over the back plate, and their purpose is to keep the longer leaves from separating unduly under the rebound action. The rebound clips also help to distribute the load over the spring plates, and without them it is probable a back plate would break when put into service.

There are three methods of forming the eyes at the ends of the back plate. In some cases the ends of the spring plate are rolled upward, as in the right-hand view, Fig. 3, and in other cases they are turned downward, as in the left-hand view. Another form of eye is the "Berlin" type, which is made without bending the metal by forging the eyes solid from the ends of the back plate. The eyes are fitted with bushings to receive the hardened and ground pins.

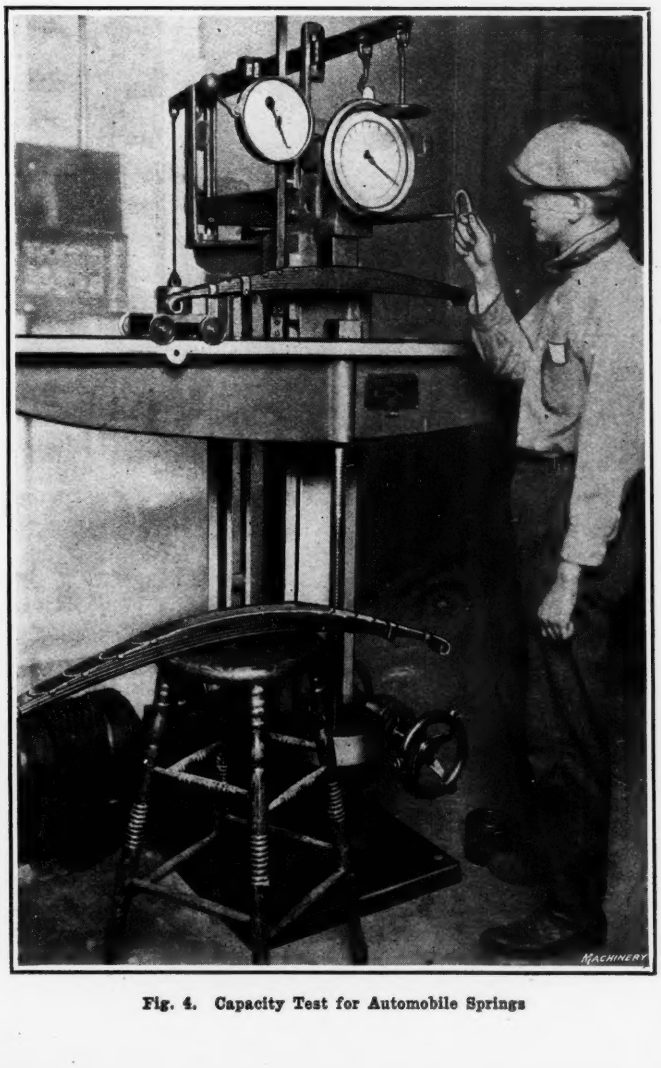

Fig. 4. Capacity Test for Automobile Springs

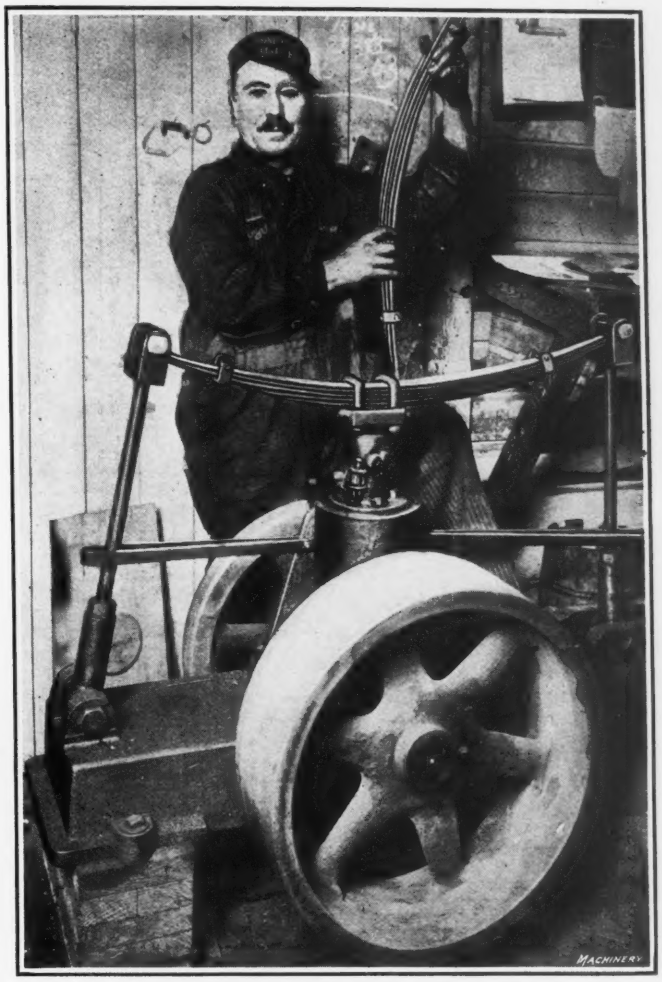

Fig. 5. Vibratory Test for Automobile Springs

In order to make a neater spring and to give a better spring action by relieving the abrupt strain that would be induced if the ends were left full thickness and square, the ends of the spring plates are thinned down and shaped, usually in one of the five ways shown at the left-hand side of Fig. 3. These consist of the square type of plate end, the round, egg-shaped, French, and diamond end. An end similar to the diamond shape, but with the stock left full thickness and not beveled, is also used occasionally.

To prevent the different spring leaves from swinging out of line, each plate is keyed to the one it rests upon. In Fig. 3 at the right are shown three methods of keeping the spring plates in alignment. First is the "slot-and-bead" method, in which each plate is slotted and guided by a pin in the plate beneath. Next is the "ribbed" method, in which a rib pressed in each spring plate meshes with the rib in the succeeding plate. A third method is by means of side lips. In this case the ends of the spring plate are forged out and trimmed to form lips, which are turned over so that they fit closely over the edges of the plate beneath.

Manufacture of Automobile Springs

At present, almost half the springs made in this country are made of vanadium steel. Many are made of chrome-silicon-manganese steel, and some are made of high-carbon steel. There are no unusual operations performed in the manufacture of automobile springs unless it may be the fitting, or cambering, of the spring plates. The stock comes in long strips and the first step is to shear these strips into the right lengths for the various leaves, or plates. In the case of the back plate, the eyes are formed; the other plates are thinned down at the ends, either by rolling or grinding, and the ends are trimmed to the proper shape. Each plate is then punched with a center hole for assembling and goes to the fitting department.

For years the method of shaping, or cambering, the plates of a spring has been to form them while hot to approximately the desired shape in bending dies. Following this operation,

each plate is carefully fitted, by hand, for the position in the spring into which it is to go. After one set of spring plates has been fitted, a temporary bolt is put in to keep the leaves of that individual spring together until they are hardened, ground, and finally assembled. The operators at the fitting fires become very proficient in their work, but at best the operation is a slow one.

The modern method of cambering spring plates is by means of spring-forming machines. These machines differ in design, but the principle of action is essentially the same in all, it being the bending and hardening in one heat. The Lewis machine carries a heavy forming turret, having two working faces, each of which is fitted with a pair of forms composed of adjustable fingers. The spring plate, after being heated to a hardening heat, is placed between the forms on the upper turret face and quickly shaped by the dies. Then while the plate is firmly held, the turret revolves and quenches it in the hardening tank beneath, thus forming and hardening the springs in one progressive operation. The pressure of the dies is maintained during hardening, thus preventing the spring from losing its shape. While the spring plate is cooling, the other turret face is presented and another spring plate is placed between the dies and the operation repeated. This method of spring-plate forming has an advantage over hand forming in that the original fiber structure of the plate is not disturbed by hammering. Moreover, this method is very rapid, as the machine will form and harden 1800 plates per day.

When spring plates are fitted by hand, they are hardened at the same time by the fitter, each plate being treated separately. The hardening heat ranges from 1650 to 1750 degrees F. The plates are quenched in oil, and in many shops are tempered by flashing off the oil. This is an uncertain method, however, as the flash points of oils vary greatly. The best practice consists in drawing the spring plates in a salt bath, as the temperature can be accurately controlled and the results are far more dependable.

The eyes of the back plate are now fitted with bushings for the pins and the rebound clips are riveted to the ends of the proper spring plate. The ends of each spring plate are ground and polished to give them a finish and to permit better sliding action, and then they are assembled with the proper center bolt. In some spring-making plants high-grade graphite paste is smeared between the leaves of the spring to reduce the sliding friction. The spring is now complete and ready for testing.

Testing Automobile Springs

Automobile springs are commonly given two tests—the capacity and the vibratory test. At the testing laboratory of the Penn Spring Works of Baldwinsville, N. Y., through whose courtesy these testing data are given, every spring manufactured is subjected to a capacity test, as shown in Fig. 4. The testing machine is made by the Tinius Olsen Testing Machine Co., and is provided with a beam that carries two roller blocks on which the ends of the spring to be tested are supported. This is necessary in order that the springs may lengthen easily as the testing pressure is applied. It will be noticed that there are two dials on the machine. The smaller of these registers the amount of deflection of the spring, while the larger indicates the load. The spring is first mounted on the roller blocks and the plunger of the machine brought lightly down against the short plate. After the plunger has been set against the open spring, the pointer of the smaller dial is turned to zero. Pressure is now applied on the back of the spring and it must register on the capacity dial at the rate of 175 pounds for each inch of deflection, in the case of the particular spring shown being tested. This spring is one-half of a full elliptic spring and the specifications call for carrying a normal load of 1580 pounds at a four-inch opening of the spring. As the full opening of the spring is 13 inches and at 4 inches opening the spring is deflected 9 inches, it will be seen that 1580 pounds represents about 175 pounds for each of the 9 inches of deflection, which is as desired. All springs are set so that a tensile stress of not over 80,000 pounds per square inch will be developed in one-half the spring, at 6½ inches deflection.

The vibratory test is a test to destruction, and is performed at the Penn Spring Works on a machine like that shown in Fig. 5. In this case the spring selected is held firmly at the ends while the center is fastened to a plunger that, by means of an eccentric crankshaft, is given rapid vibrations of 3 inches in length. A spring is put on the machine and vibrated until it gives out by a plate breaking or in some other way, an accurate count of the number of vibrations being kept.

* * *

ELIMINATING WASTE IN MANUFACTURING AND ASSEMBLING

BY H. D. MURPHY[1]

The compilation of data on factory transportation which Edward K. Hammond presented in the July and August numbers of MACHINERY is instructive, and although applying more particularly to the handling of materials on a large scale, these articles contain suggestions that can be modified for the use of the small plant. The writer was particularly interested in the paragraphs in which Mr. Hammond pointed out the loss entailed through having men waste their time at the stock-room door. The necessity for having a comprehensive system for giving out parts for assembling was brought home to us, however, in another way. The assemblers had contracted a habit of accumulating more parts than were needed for any given job and hiding the surplus under their benches. This condition was brought to light shortly after a reliable cost system was inaugurated, when it was discovered that orders were being placed in the machine shop for parts of which there were really sufficient on hand. The first step taken to overcome this was to issue positive orders to the stock clerk that no claimed shortages of the assembling department were to be filled without the sanction of the office.

However, another difficulty arose in that certain parts often were not ordered until actually needed by the assemblers. This, of course, meant failure to keep the shipping date promised to the customer. The following system was therefore evolved. The stock-room was given a card showing each part and the quantity that went into every assembled unit. Whenever an order was issued to the assembling department, a copy was sent to the stock-room. Upon receipt of this copy, the stock clerk consulted the card for the particular unit covered by the order and put all the necessary parts in a tote box. This box was put on a shelf subject to the call of the foreman. At the same time, a list of the missing parts was sent to the office and the necessary orders for making these were, in turn, issued to various machine shop departments. When the assembling foreman was ready to proceed with an order, he would notify the stock clerk, and if all the parts were completed, the tote box would be carried to the bench of the assembler by a stock-room helper. If parts were still needed to complete that particular order, the stock clerk would notify the foreman, who would then designate the next most important order.

This arrangement has accomplished four desirable objects: it has enabled the stock clerk to anticipate the wants of the assembling department; it has removed the slightest excuse for the workman leaving his bench or machine for a friendly visit at the stock-room door; it has done away with the secreting of parts under the bench; and it has also, and this is by no means least in importance, enabled the cost department to show what is actually made and used instead of simply reporting what should be used. The latter can be determined from any intelligently made drawing, but the former is knowledge which is vital to the success of the business.

* * *

An example of a variable standard and the confusion that arises from lack of general agreement is found in the perch used for measuring stone work. The perch is legally defined in some of the older states as 24¾ cubic feet, but the standard is not universal, as in some states it varies from 16½ through 20, 22, 25, to 27 cubic feet. In other states it is defined as equivalent to 2200, 2500, 2700, 2800 and 3000 pounds. The danger of using a variable standard like this is obvious, as contracting parties might have in mind entirely different conceptions of the value of the unit.

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FORMING MILK-CAN HANDLES ON A POWER PRESS

DESIGN OF DIES FOR COMBINED DRAWING AND BENDING

BY ERNEST A. WALTERS [1]

THE making of a milk-can handle is one of the many difficult power-press operations that require the exercise of much patience and good judgment to obtain the proper development and to get the dies into perfect working order. One of the difficult operations in press work is deep bending and drawing, because the blank has a tendency to shift before it is forced to the bottom of the die, which results in imperfect work. Another difficult operation is cross bending, when a large radius is greatly reduced, thereby making it necessary to upset the stock and condense the material without wrinkling or distorting the piece. In designing the dies for these handles, these difficulties were met, and the dies developed produce the desired number of perfect handles per day without much labor. The second and third operations, Figs. 5 and 6, have been arranged so that they may be performed with tandem dies in a single press, if so desired, thus requiring only two presses for the job. This arrangement also eliminates the labor required in handling the work between two presses.

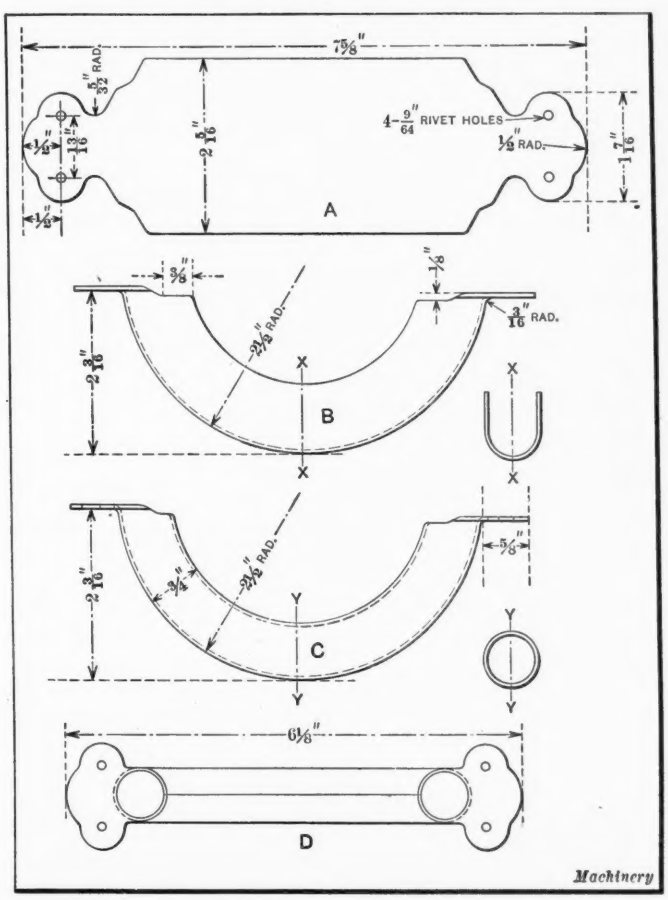

Fig. 1. Operations in forming Milk-can Handle

Fig. 1 shows the blank, which is made of No. 18 cold-rolled deep-drawing steel. The piece *A* is blanked on the progressive punch and die shown in Fig. 2. The punch *A* is made of tool steel and is hardened and dovetailed in the cast-iron holder *B*. The tool-steel perforating punches *C* are hardened and ground to size and are held in position by set-screws *D*. The blanking die *E* is made in two sections with the proper shear. It is hardened and ground and is held in the cast-iron die plate *F* by fillister-head screws *G* and dowel-pins *H*, which are shown in the plan view of the die, Fig. 3. The blanking die *E* and plate *F* are sunk in the cast-iron bolster plate *I* and are held in position by screws *J*. The stripper *K* is made of machine steel and is held in position by cap-screws *L* and dowel-pins. The spacing gage *M* is made of tool steel and is hardened and ground. Fig. 3 shows the guide plates *N*, finger-gage *O*, and spacing gage *M*. When straight strip steel is used, a die of this design will be found accurate enough. When a high degree of accuracy is essential, a compound blanking and perforating die is recommended.

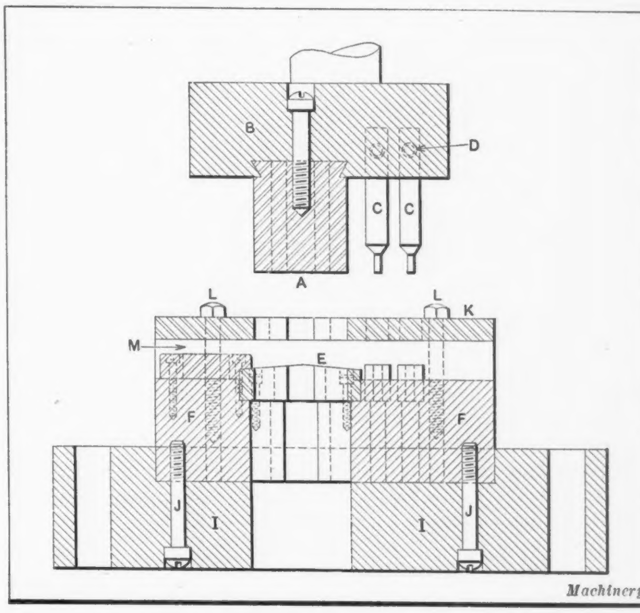

Fig. 2. Front View of Progressive Blanking Punch and Die

Fig. 4 shows the strip of steel and the method of gaging. The sheet of steel *P* is first held against the side *R* of the finger-gage *O*, Fig. 3, and a slight cut *S*, Fig. 4, is taken at the first stroke of the press. Gage *O* is then withdrawn to clear the sheet of steel, which is pushed forward against spacing gage *M*, bringing the gage points *T* and the sheared edge *S* together. Blank *A*, Fig. 1, is then cut. When the first blank is removed it is obvious that the stock will fit over gage *M*, and blanks can be produced continuously.

In the second operation the blank is bent in the die shown in Fig. 5 and formed to U shape as indicated at *B*, Fig. 1.

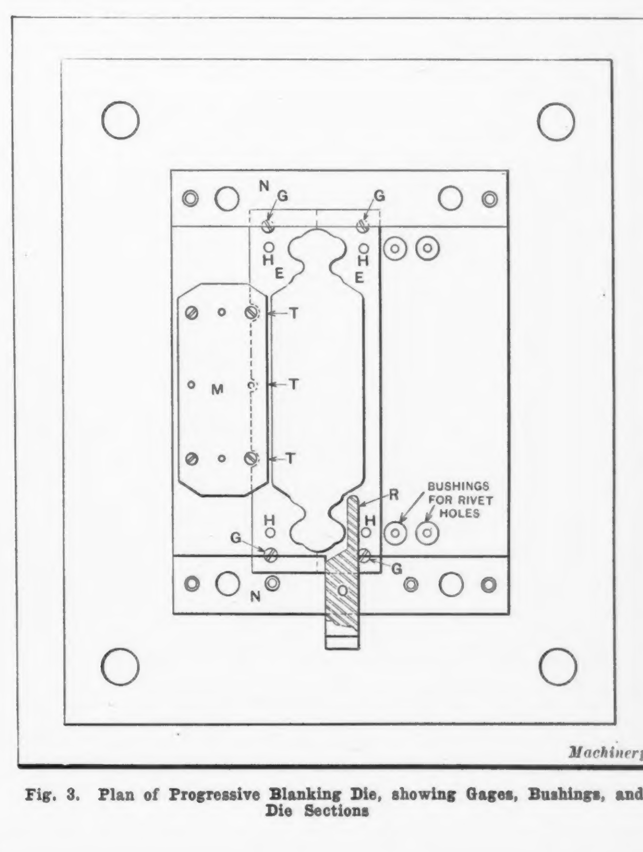

Fig. 3. Plan of Progressive Blanking Die, showing Gages, Bushings, and Die Sections

[1]Address: 234 W. Buena Vista, Highland Park, Mich.

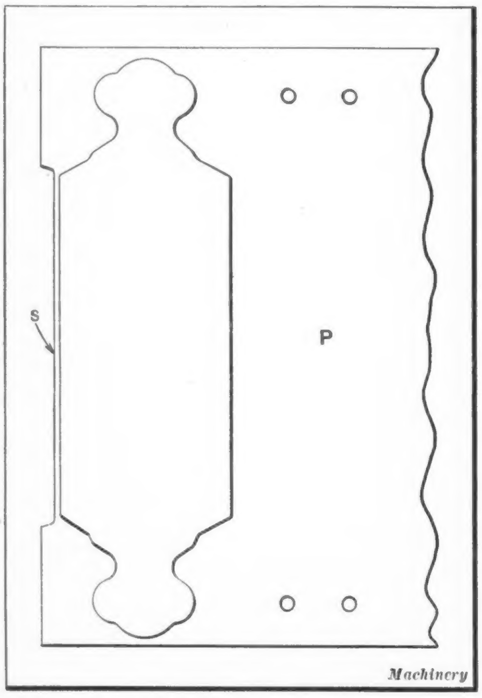

Fig. 4. Blanking Strip after Second Stroke, illustrating Manner of gaging

The punch *A* is made of tool steel and is backed by a hard plate *B*, so that the ends of the handle will be flattened when the die closes. Punch *A* and plate *B* are fastened to the cast-iron punch-holder *C* by screws *D* and dowel-pins *E*. The die *F* is made of tool steel and is hardened and held to the cast-iron plate *G* by screws *H*. Gages *I* are held in place by screws *J* and dowel-pins.

The square pressure bar *X* is slightly hollowed at the top *K*; it is made of tool steel and is hardened and ground to a sliding fit. The punch *A* is knurled at *O*, and with the proper tension on the pressure bar *X* from the rubber bumper *Y* and the adjusting nuts *Z*, will grip the blank and hold it from shifting while it is being bent to shape. The side gages *L* are made of tool steel and are hardened in oil; they prevent the blank from shifting sideways. The gages are held in position by bolts *M* and have the necessary clearance at *N* when closed.

The handle is formed to its completed shape as shown at *C* and *D*, Fig. 1, in the die shown in Fig. 6, which is designed to operate in tandem with the forming die, Fig. 5. The die *A* and the punch *B* are made of tool steel and are hardened in oil because of the strain developed when closing the handle. If this die and punch are hardened under ordinary conditions, they will crack and chip and cause trouble. The punch *B* is held to the hard flattening plate *C* and the cast-iron punch-holder *D* by screws *E* and dowel-pins *F*. The die *A* is set into a cast-iron plate *G* and is held in position by screws *H*. The forming and the closing dies must be kept polished and free from scratches to produce the best results.

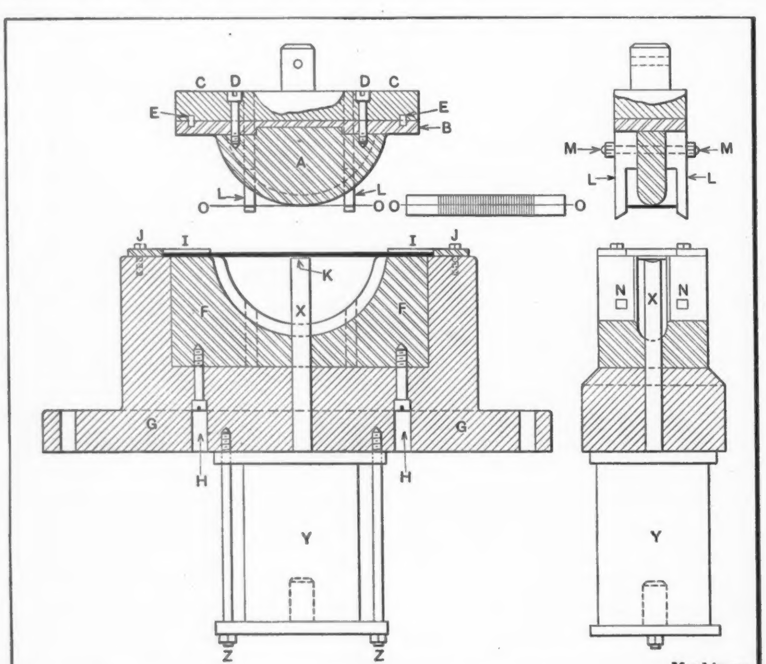

Fig. 5. Forming Operation

WOMEN IN BRITISH MACHINE SHOPS

The Ministry of Munitions in Great Britain recently exhibited at Leeds an extensive collection of work done by women in the mechanical industries. The exhibition indicates the extent to which women have taken men's places in England. There were fourteen separate groups of exhibits. One of the most interesting, to a mechanic, was a group of gages, including thread, ring, and plug gages, made to limits of 0.0003 inch. The plug gages made to these limits were completed entirely by women, including cutting off the stock, turning, casehardening, grinding, lapping, inspection and final corrections. One hundred and sixteen specimens of twist drills, milling cutters, reamers, drill chucks, chasers, etc., many of which were made entirely by women, were exhibited in another group. In some works, the women do all the machining operations, except the hardening, tempering, sand-blasting, and final grinding, while in other shops these operations are also done by women.

The group containing dies and punches for cartridge making is of peculiar interest on account of its intimate relation to the war. Sets of dies for this work are made entirely by women, except the backing off and hardening. Projectiles produced entirely by women were shown in another group, including among other exhibits 4.5-inch howitzer cartridge

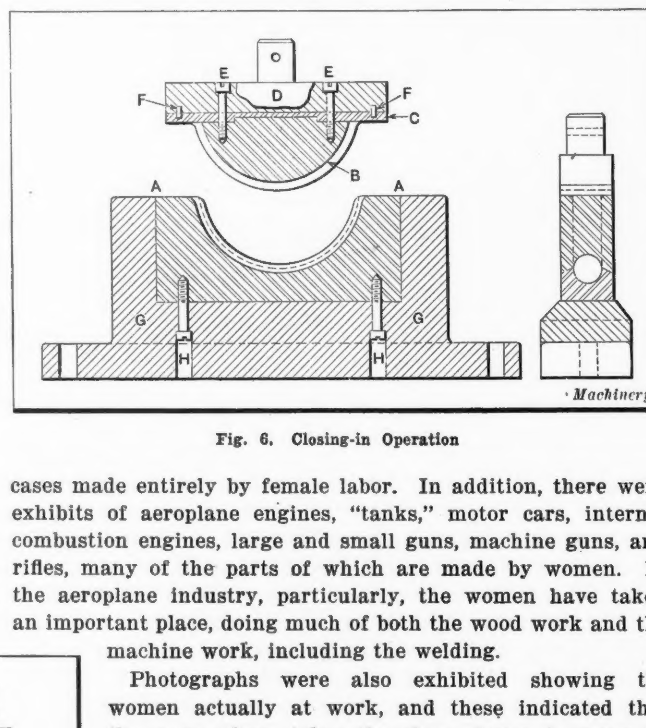

Fig. 6. Closing-in Operation

cases made entirely by female labor. In addition, there were exhibits of aeroplane engines, "tanks," motor cars, internal combustion engines, large and small guns, machine guns, and rifles, many of the parts of which are made by women. In the aeroplane industry, particularly, the women have taken an important place, doing much of both the wood work and the machine work, including the welding.

Photographs were also exhibited showing the women actually at work, and these indicated that the women have taken the place of men in many industries requiring heavy labor, in which it would ordinarily be thought that their lack of physical strength would prevent them from engaging. Women, for instance, were seen working at coke ovens, discharging and quenching coke, stacking and loading it in railway cars, handling it in connection with aerial rope-ways, etc. In rolling mill work, they were seen handling steel rails, punching spike holes in light rails, and charging the rail-mill furnaces. In steel works, they were seen working around furnaces and handling billets, operating hydraulic presses, and doing a variety of similar work. In the foundries, they are making cores both by hand and by machine, machine molding and general labor.

Judging from this exhibition, one would be inclined to draw the conclusion that the war is fought just as strenuously by the English women as by the men, and that the credit for the results that will be achieved will be equally divided between those who are fighting valiantly at the front and those who are fighting equally courageously at home.

IMPROVING A MOLDING MACHINE

BY S. W. PALMER [1]

Fig. 1 shows what is known as the "Modern" arcade molding machine. A number of these machines gave satisfactory service on certain lines of work, but on others they proved so unsatisfactory that it was decided to rebuild several to suit the work. The object of the change was to increase the pressure exerted by the machine on the surface of the mold, so that patterns of a relatively large area could be suitably molded with less hand ramming. In the machine furnished by the manufacturer, compressed air is admitted to the head end of an air cylinder anchored at A. The force of the air acting against the piston is transferred through a piston-rod to pin B in a bellcrank that is free to rotate about point D.

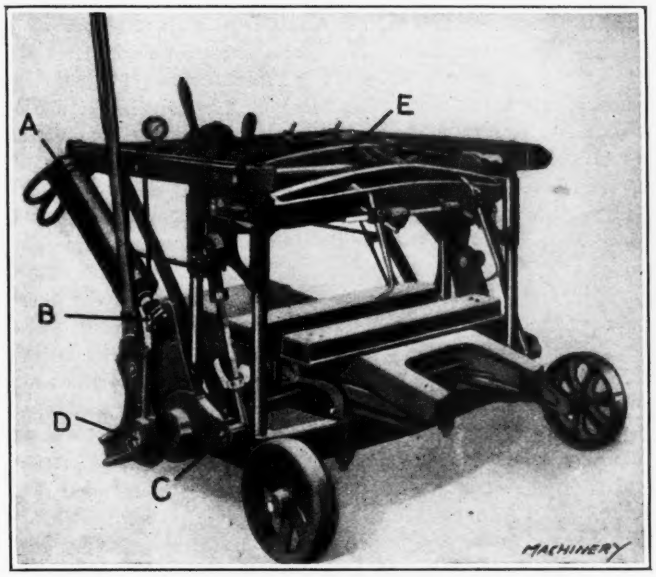

Fig. 1. Molding Machine as furnished by Manufacturer

As the bellcrank rotates in a clockwise direction, head E is drawn down by the connecting-rod attached to pin C. The original position of these parts is indicated in Fig. 2 by the solid lines connecting points A, B, D and C. When the machine is in the squeezing position, the moving points B and C have taken the positions B_1 and C_1. This mechanism is the same on both sides of the machine.

The change consists in replacing the cylinder on the left-hand side of the machine with one of larger diameter and shorter stroke, and that on the right-hand side with one of larger diameter but the same stroke. The position of the points A, B, C and D on the improved machine when the squeezing head E is up, as in Fig. 1, is shown in Fig. 4. The left-hand side of the machine is indicated by the solid lines joining points A, B_1, D_1 and the dotted line to C_1, and the corresponding parts on the right-hand side of the machine take the positions A, B_2, D_1 and C_1.

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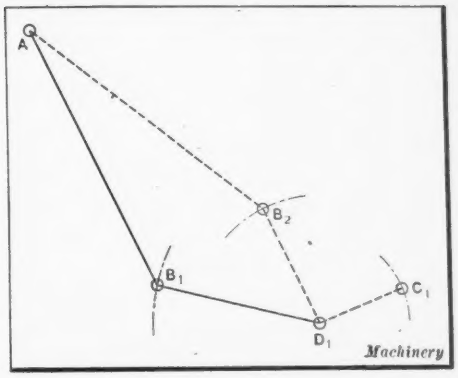

Fig. 4. Position of Air Cylinders, Pistons, and Bellcranks before Operation on Improved Machine

After the air has been turned into the cylinders and the machine has reached the position of squeezing, the squeezer head being down on the flask in the final position, the cylinder and attachment on the left-hand side of the machine occupy the position shown in Fig. 3 by A, B_3, D_1 and C_2. Those on the right-hand side occupy the position A, B_4, D_1 and C_2. It will be noted that the arrangement of the moving parts of the left-hand cylinder, crank and connecting-rod is such that, at the bottom of the stroke, when the maximum pressure is required on the squeezing head E, the angle AB_3D_1 is much more nearly a right angle than is the angle AB_4D_1, which is the angle of the new parts on the right-hand side of the improved machine and on both sides of the old machine. It will also be noticed that the pressure on the line AB_3 is working on a radius B_3D_1 which is of considerably greater length than that of the cylinder working on the line AB_4, with a radius B_4D_1.

In order to show the advantage gained by the greater turning effort thus produced, the following mathematical calculation is necessary. The original machine is equipped with two double-acting 4-inch cylinders of 15-inch stroke. For each mold made, each cylinder must be filled twice with compressed air at 80 pounds pressure, thus requiring $2 \times 2 \times 2 \times 2 \times 3.14 \times 15 = 754$ cubic inches of air. The improved machine is equipped on the right-hand side with one double-acting 5-inch cylinder of 15-inch stroke, and on the left-hand side with one single-acting 5-inch cylinder of 8½-inch stroke. The arrangement is such that for most work the 15-inch cylinder is sufficient to return the squeezing head to the original position after the mold has been finished. However, the short cylinder on the left-hand side of the machine is so arranged as to take air during the last two inches of the return stroke and thus help out the right-hand cylinder when very heavy patterns are being molded.

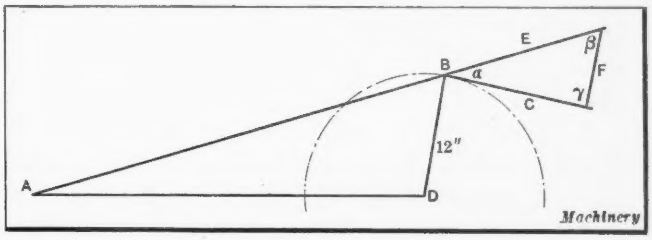

Fig. 5. Force Diagram of Original Machine

By computing the turning effort exerted by each machine on shaft D, it is possible to get a fair comparison of the two machines, as the power from this point is transmitted to head E in the same way and through the same angles in both machines. The turning effort of the original machine with 80 pounds air pressure is $2 \times 2 \times 2 \times 3.14 \times 80 = 2010$ pounds, which is exerted along line E, Fig. 5. The effective effort of this force is represented by the tangent C, which equals $E \cos \alpha$, or $2010 \times 0.891 = 1791$. As the radius is one foot, this gives 1791 foot-pounds as the turning moment about point D.

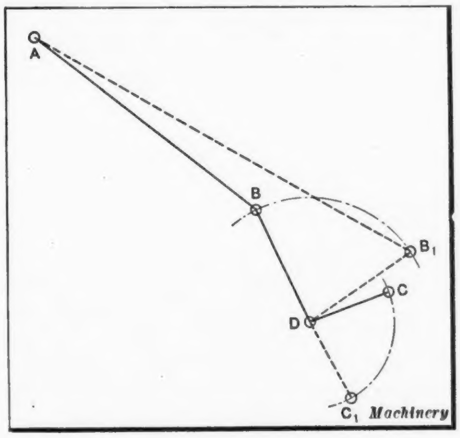

Fig. 2. Relative Positions of Air Cylinders, Pistons and Bellcranks before and after Operation on Original Machine

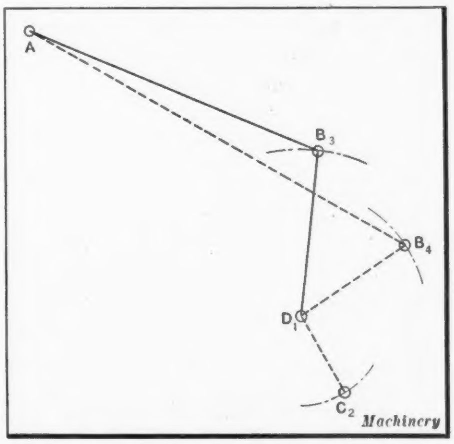

Fig. 3. Position of Air Cylinders, Pistons and Bellcranks after Operation on Improved Machine

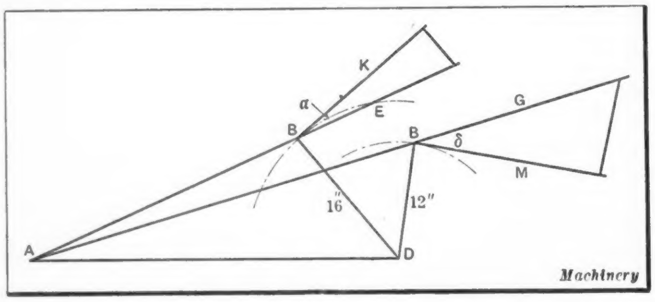

Fig. 6. Force Diagram of Improved Machine

The corresponding effort on the improved machine with the same pressure in the short cylinder is 2.5 × 2.5 × 3.14 × 80 = 1570 pounds; this is exerted along line *E*, Fig. 6. The effective force equals the tangent *K*, which is equal to *E* cos α, or 1570 × 0.961 = 1509 pounds. This pressure, acting on a radius *DB* of 16 inches, or 1 1/3 foot, equals 1509 × 1.333 = 2011 foot-pounds turning effort exerted about point *D* by the left-hand cylinder only. On the right-hand side of the machine the effective effort is the tangent *M*, which equals *G* cos δ, or 1570 × 0.891 = 1399 pounds. As the radius *DB* is 1 foot, this gives 1399 foot-pounds for the long cylinder only. The total turning moment about point *D* is the sum of the turning effort exerted by each cylinder, or 2011 + 1399 = 3410 foot-pounds, as compared with 1791 foot-pounds in the original machine, or almost twice the effective pressure. This turning moment is obtained by the use of the following amount of air. First, assuming that the mold is of such size that the long cylinder alone can lift the squeezing head to its original position, the original machine requires both cylinders to be filled with air twice for each complete mold, or 2 × 2 × 2 × 2 × 3.14 × 15 = 754 cubic inches of air. The improved machine requires 2 × 2.5 × 2.5 × 3.14 × 15 + 2.5 × 2.5 × 3.14 × 8.5 = 756 cubic inches of air, or two cubic inches more than the old machine.

If the pattern is so heavy that the short cylinder is required to complete raising the squeezing head *E* to its original position, the amount of air required is 2 × 2.5 × 2.5 × 3.14 × 15 + 2.5 × 2.5 × 3.14 × 8.5 + 2 × 2.5 × 2.5 × 3.14 = 795 cubic inches, as against 754 cubic inches in the old machine. In both cases the improved machine is exerting a pressure to squeeze the mold of 3410 foot-pounds, as against 1791 foot-pounds on the original machine. After gaining this extra power it was, of course, necessary to brace and strengthen a number of the parts of the machine to withstand the increased strain without excessive deflection. Several of these machines have been used for some time on heavy work and are giving satisfactory results.

* * *

REVENUE FROM MOTOR CARS

According to the Department of Agriculture, in 1916 there were 1,067,332 more motor cars registered in the United States than in 1915, an increase of 43 per cent. The gross total of registered cars, including commercial cars, was 3,512,996; the number of motorcycles registered was 250,820. The several states collected in registration and license fees, including those of chauffeurs and operators, a total gross revenue of $25,865,369. Of this amount, 92 per cent, or $23,910,811, was applied directly to construction, improvement or maintenance of the public roads in forty-three states. The figures for 1916 correspond closely with the annual percentage increase of motor-car registration of the last three years. This yearly increase has averaged 40 per cent in the number of cars and 50 per cent in revenue. In 1906, the total state registrations were approximately 48,000 cars, and the several states collected in fees and licenses $190,000; only a small part of this was applied to road work.

* * *

The British minister of munitions has fixed the selling price of aluminum ingots of ordinary commercial purity, 98 to 99 per cent, at £225 (about $1090) per ton and the maximum selling price of remelted aluminum scrap and swarf ingots of 98 to 99 per cent purity at £210 (about $1020) per ton.

THE HEART OF THE FACTORY

BY ARTHUR JENNER[1]

As the heart is to the human system so is the tool department to the modern factory. If that department is not operating as it should, the condition is reflected in decreased or inefficient production. Quantity manufacturing of interchangeable parts requires that the necessary tools be produced as economically as possible and upon schedule time. Economy means not necessarily cheap tools, but such as are fitted for their intended functions and made as good as possible and on time. The provision of plenty of relatively inexpensive accessories is positive economy, not only in dollars and cents, but also in increased production due to the psychological effect on the toolmakers or machinists. Many jobs take more time to set up than to machine.

Illustrations are not rare in the advertising pages of technical journals that show the lack of common necessities for holding down work. Bolts six or more inches longer than necessary are often used, the extra length requiring the use of large nuts, collars, old hubs, washers, etc. Dividing heads and tailstocks are robbed of the proper bolts, and even small carriage bolts and such substitutes are used at the risk of spoiling the job through inefficient holding power. But the search for better facilities would cost much more in time and temper than the value of the missing equipment. One of the worst results of this condition is the effect upon the men. Order and neatness are not encouraged, so that when these men get into a shop where better conditions exist, they cannot immediately change their habits, and to some extent the well-equipped shop suffers.

This fact was brought forcibly to the writer's attention some years ago when taking charge of a tool-room that had not received the proper attention. The machines were good, but the important, though less expensive, details were lacking. Casehardened bolts and nuts of sizes to suit the various machine T-slots, and from 2 to 10 inches long, were provided, also casehardened U-straps, 3, 5 and 7 inches long, and soft plate straps, 3/4 inch by 2 1/2 inches by 8, 10 and 12 inches. Small hardened and ground parallels, 1/4 by 3/8 inch to 1/2 by 1 1/8 inch, and large cast-iron ones were made. Every man was supplied with a surface plate, and a few spare plates were kept on hand for extra help; true angle-irons in several sizes were also made. All lathe centers were marked to denote the make of lathes they fitted, were rehardened and ground, and spare ones made, together with half centers. Tap sets, with the proper drills and counterbores fitted to hardwood blocks, were made in ample quantity, and every toolmaker was supplied with a set of drills, in blocks, from No. 1 to 60. Lapping plates for gage-makers were provided, replacing die-shoes and other odd-shaped castings required for specific purposes. Cast-iron lap blanks and suitable adjustable holders for use in lapping plug gages, etc., were carried in the tool crib in various sizes, as also were small lead laps, cast on cold-rolled steel centered arbors ready to turn, for use in lapping jig bushings, ring gages, etc. Wrenches were supplied and marked for use on certain machines, the originals having been used for other purposes. The tool crib was rearranged to enable the mechanics to observe at a glance and thus select odd-shaped and special tools, cutters, etc. Also the tools most in demand and small supplies were placed as near as possible to the point of distribution, resulting in much better service from the tool crib. Reflectors and shades for electric lamps were supplied, and many other details received attention along the line of general betterment. The establishment of the foregoing system was inexpensive as compared with the resultant all-around improvement.

Once in a while a man would be employed who did not fully appreciate the fact that it was to his advantage as well as that of his employer to have the equipment kept in proper order, and care was required to see that he got into the spirit of this system. This was not due so much to want of thought as to his having been employed in shops that did not possess any carefully studied plan of caring for the upkeep of the means of quantity production.

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BALL BEARINGS[1]

FACTORS GOVERNING DESIGN — METHODS OF DETERMINING OVERLOADING OF BALLS — GYROSCOPIC EFFECTS

THE ball bearing of today could never have been made a commercial success but for the high degree of accuracy attained in its manufacture. With a load of 130 pounds, a half-inch ball is compressed 0.001 inch. Hence if one of the balls in a thrust bearing is 0.001 inch larger than the rest, the ball will have 130 pounds more load upon it than the others. As the total load that may be put on a half-inch ball running at very low speeds on a curved track is about 250 pounds, an error of 0.001 inch in the diameter of the ball, or a place in the race 0.001 inch high, will increase the load to such an extent that failure of the ball is certain to occur. With a one-inch ball, the safe load is about 1000 pounds, and the effect of 0.001 inch error, 200 pounds.

Except in the smaller sizes, balls in a properly designed bearing hardly ever break into pieces when overloaded, but the surface chips or peels off. The safe-working load of a ball depends on the strength of its surface to withstand the continual compression and expansion under load, or, in other words, on the elastic limit of the surface. It does not follow, however, that the ball with the highest crushing load will have the highest safe-working load. The safe-working load of a bearing depends not only on the quality of the ball, but on the design of the bearing and the accuracy with which it is ground. At high speeds, the safe loads per ball are much less than at low speeds; hence, with a fast-running bearing, it is of much greater importance to get extreme accuracy of workmanship than in a slow-running bearing. Balls running on a curved track will carry from 2 to 2½ times as much load as those on a flat track. Why the load-carrying capacity of a ball bearing diminishes with the speed is not altogether clear. It is sometimes said that the diminished capacity is due to the increased load on the balls caused by centrifugal force; but on calculating the amount of this force it will be seen that the increased load due to this cause is so small as to be negligible except at very high speeds. With balls running in a properly fitted cage with flat ball-races, it is difficult to see how the centrifugal force of the balls can have any effect on the load-carrying capacity of the bearing. The speed effect on the balls has possibly some relation to the well-known effect of very rapid reversals of stress.

All authorities agree that the effect of speed is much more marked in thrust bearings than in radial bearings. In a thrust bearing the balls are always under the same load, but the direction of their line of loading is always changing. In a radial bearing, however, the balls are gradually loaded for a fraction of a second, and then gently released from stress; at least half the time they get a complete rest, as regards supporting any load, which appears to enable them to withstand higher loads at a given speed than they are capable of doing when in a thrust bearing.

Curvature of Tracks and Mounting

Prof. W. Schwinning has stated that a curved track is the best shape for races of radial bearings intended for heavy loads. Hertz's theory shows that for a given load the maximum stress in the material is smaller the greater the extent of contact between the balls and the races, and therefore it is desirable, in order to maintain the maximum bearing capacity, to make the radius of the groove of the inner ball path from 4 to 5 per cent, and that of the outer ball path from 10 to 15 per cent larger than the radius of the balls.

With grooved races, the normal continuous load, in kilograms, can be taken as $W = 15 \dfrac{n}{5d^2}$,

in which n = number of balls;

d = diameter of balls, in ⅛ inch.

This relation is suitable for medium speeds of, say, 800 revolutions per minute, assuming absence of shock. If shocks are probable, the normal load on the bearing must be reduced. The races should contain as many balls as possible.

In the case of a nearly perfect roller or ball bearing the frictional resistance of the bearing is practically independent of lubrication. For a single-row, radial bearing, having a diameter of outer ball track, 2.75 inches; radius of curvature of outer race, 0.275 inch; diameter of inner ball track, 1.75 inch; radius of curvature of inner race, 0.2625 inch; diameter of ball, 0.5 inch. If the ball deflects so as to approach the race by 0.0001 inch, the area of contact on the outer race is 0.00057 square inch, and the area of contact on the inner race is 0.00063 square inch.

Creep in journal bearings is due to the slight difference in diameter between the shaft and the bore of the inner race of the bearing, so that the revolving shaft rolls around the bore of the inner race as it rotates. If the diameter of the shaft is 0.001 inch smaller than the bore of the bearing, its circumference is approximately 0.003 inch less, and in each revolution a point on its surface will travel 0.003 inch less than a point on the bore of the bearing. If the shaft makes one thousand revolutions per minute, the surface of the bore will, theoretically, creep forward three inches in each minute. The only way to prevent this creep is to make certain that the revolving races are a tight fit, and are clamped endwise on the shaft. Grub screws or keys are not satisfactory. There is no tendency to creep between the outer race and its housing where these are both stationary, or between the shaft and inner race if these are both stationary. This is because the load remains continually in the same direction; when the load revolves, the outer race will tend to revolve in the opposite direction to the load.

A journal bearing that has to withstand pure end thrust and no journal load has the end thrust evenly distributed over all the balls. When the bearing is subjected to combined journal and thrust load, the journal load is carried on two or three balls which are held by this load in the bottom of the tracks. A side thrust coming on this bearing at the same time will be carried by the same two or three balls, and therefore the load per ball will be greater. The balls that are not subject to the journal load, and are therefore slack in their races, will not be carrying any of the side thrust.

Method of Determining Overloading of Balls

The wear of properly made ball bearings is practically nil when run at suitable loads and speeds. A new ball, straight from the makers, when examined shows slight defects; but after running a few weeks under a moderate load, the surface improves. When, however, the ball is overloaded it appears to be covered with tiny flakes of snow, which are specks where crystals have broken away from the surface of the ball. Such specks can be seen only with a lens magnifying about 300 to 400 diameters. As soon as these specks appear, it is a sure sign that the ball has been overloaded; and if the test is continued at this load the balls and races will ultimately fail. The races must be perfectly smooth and free from chatter and scratches; otherwise the load on the balls will be increased.

Prof. Schwinning says that when two balls are pressed together, the load at which the first fissure occurs is a measure of their tenacity; the breaking load does not depend only on this fissure-load. The first crack is a circular fissure surrounding the point of contact and often occurs at less than one-tenth of the breaking load; circumferential cracks occur much later. The first circular fissure cannot be seen with the naked eye, or even with a microscope, but it can be made visible by etching the balls, preferably with warm hydrochloric acid. Not infrequently criss-cross scratches, due to too rapid grinding, occur on the cylindrical surfaces of the races, especially where the tenacity of the surface has been reduced through defective hardening. These scratches are rendered visible by etching.

[1]Abstract of a paper by A. Marshall Arter, read before the Society of Engineers of Great Britain, April, 1917.

Permissible Loads for Ball Bearings

Taking the foregoing considerations into account, the author has evolved the following formulas for the permissible loads of ball bearings of the best materials and workmanship, and with curved tracks, giving approximately the same area of contact for the inner and outer races of journal bearings, which will be found to conform closely with generally accepted practice.

Thrust bearings:

$$W = 770nd^{1.45}\sqrt{\frac{320d}{ND}}$$

Radial bearings:

$$W = 900nd^{1.45}\sqrt[3]{\frac{320d}{ND}}$$

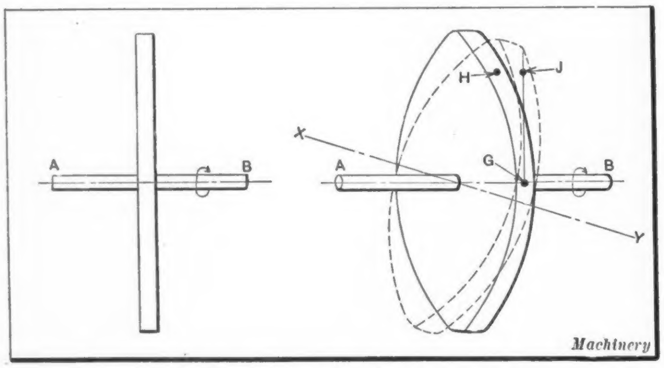

Fig. 1. Diagrams showing Effect of Gyroscopic Torque

in which W = load, in pounds;
n = number of balls;
d = diameter of ball, in inches;
N = revolutions per minute of shaft;
D = diameter of ball track (thrust bearings, center to center of opposite balls; radial bearings, diameter of inner track) in inches.

In the case of thrust bearings, all the balls carry the load simultaneously; in radial bearings, only one-fifth of the balls take the load at one time. But in the latter case the area of contact of the balls is greater than in the former, and consequently their load-carrying capacity is greater, due to the cylindrical formation of the outer race and the smaller radius of track of the inner. In thrust races, a satisfactory permissible load has been found to vary inversely as the cube root. The effect of shock is extremely important and with hardened steel surfaces in metallic contact the inertia of the moving parts subjects the bearing to an extra load, which must be taken into consideration when determining the size of a bearing.

Gyroscopic Effect

When the axis in a ball bearing about which the balls rotate is not parallel to the axis of the bearing, there is a gyroscopic couple, due to the action of each ball as its axis of rotation "precesses" in a radial path. Suppose a disk to be rotating in a clockwise direction when viewed from the end of spindle B, Fig. 1, and spindle AB to be precessed about an axis at right angles to AB, so that the end A rises vertically from the surface of the paper while B descends below it. Then, by the principle of "conservation of angular momentum of aspect," any point G on the rim of the disk will tend to run in its original aspect of rotation, and a gyroscopic force will ensue, acting at right angles to the plane of precession.

In Fig. 2, A represents a disk in edge aspect, and, when its spindle is precessed as shown in the previous illustration, it will assume positions B and C, successively. Each of these positions is a different "position of aspect." Now, imagine that for an infinitesimal period of time the mass of the disk is equally divided and concentrated at four points e, f, g and h, as shown at D. Now, considering point G, Fig. 1, as representing point e, Fig. 2, on precession, its rotation will cause it to travel to a position shown at H, Fig. 1; but, owing to the precession and its original momentum of aspect in a plane at right angles to the surface of the paper, as shown at position A, Fig. 2, it actually travels to a point indicated by J, Fig. 1. A gyroscopic torque results, which tends to move the disk to the position shown by dotted lines in Fig. 1. Point f, shown at D in Fig. 2, acts in a similar manner. If the action of points g and h be examined, similar reasoning will show that a torque is set up in opposition to the precession, but this torque is counteracted at the commencement of precession, and is soon reduced to zero.

Owing to the new aspect of rotation taken by the disk represented by XY, tending to conserve the instantaneous angular momentum of aspect of points g and h, on termination of the precession, the reverse condition will be observed. The constraint by which each ball is made to change the direction of its axis is due to a frictional driving contact of the two races between which it runs. If this frictional restraint is greater than the gyroscopic couple, the balls will roll properly in their races; if the frictional restraint is insufficient, the balls will not roll in the correct manner, and skidding will take place, resulting in some loss of power and unnecessary wear and tear.

The value of the gyroscopic torque T is given by the following equation:

$$T = IWV$$

T = gyroscopic torque;
W = angular velocity of ball in radians per second;
V = precessional angular velocity in radians per second;
R = radius of ball in inches;
K = radius of gyration of ball in inches;
I = moment of inertia of ball = $K^2 \times$ mass;
d = weight of material in pounds per cubic inch.

$$K^2 = \frac{2R^2}{5}, \text{ and}$$

$$\text{Mass} = \frac{4}{3}\pi R^3 d$$

Hence:

$$I = \frac{2R^2}{5} \times \frac{4}{3}\pi R^3 d = \frac{8}{15}\pi R^5 d$$

In this particular case, where the "axis of spin" is at right angles to the "axis of bearing," the precessional angular velocity V equals $2\pi r$, where r is the number of revolutions per second of the ball around the axis of the shaft = ½ shaft revolution per second. Therefore:

$$T = \frac{8}{15}\pi R^5 d \times 2\pi r \times W = \frac{16}{15}\pi^2 R^5 d r W$$

The maximum restraining couple due to frictional contact = $2wnR$, where w = weight sustained by each ball in poundals, and n = coefficient of friction between the ball and race, that is, that proper to rolling contact under the conditions in question. This value is not known with accuracy, but may be taken as 0.1. Therefore, the limiting conditions under which a bearing will function properly are given by the expression:

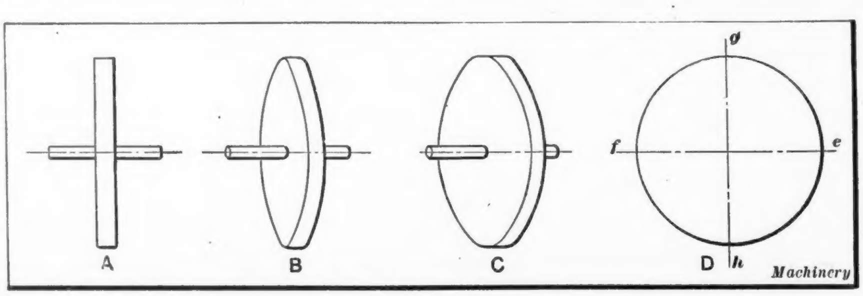

Fig. 2. A, Position of Edge Aspect; B and C, Successive Positions; D, Diagram showing Condition with Mass concentrated at Four Points

$$2wnR > \frac{16}{15}\pi^2 R^5 d r W$$

Let S = speed of revolution of shaft per second;
l = radius of circle containing balls;

then: $$W = \frac{lr}{R}; \text{ but } S = 2r$$

Therefore: $W = \dfrac{lS}{2R}$, and $V = 2\pi r = \pi S$

Therefore: $T = \dfrac{8}{15} \times \pi R^5 d \times \pi S \times \dfrac{lS}{2R} = \dfrac{4\pi^2 R^4}{15} \times lS^2 d$

Thus the limiting condition is given by the following:

$$2wnR > \frac{4}{15}\pi^2 R^4 lS^2 d \qquad w > \frac{2\pi^2}{15n} \times R^3 lS^2 d \text{ poundals}$$

Let us apply this to the following numerical example: suppose a bearing has balls 1 inch in diameter, a ball circle 6 inches in diameter, and that the shaft runs at 30 revolutions per second.

$$w > \frac{2\pi^2}{15n} \times 0.125 \times 3 \times 900 \times 0.28$$

$$w > 1250 \text{ poundals}$$

$$w > 38.6 \text{ pounds}$$

The meaning of this result is that if a thrust bearing is designed according to the preceding data and the load on any ball falls short of 38.6 pounds at any time, that ball will begin to skid, owing to the effect of its gyroscopic torque. It is evident that under conditions of practice at full load, no slippage will take place if in a well-designed bearing a 1-inch ball is loaded up to many times the slipping limit. It would appear, however, that at light loads there is some danger that gyroscopic slippage may take place. In a motor car, the maximum load for which a bearing has to be designed is very often many times greater than the ordinary working load, which, in its turn, is considerably above the load frequently existing. From this, it will be seen that there is a minimum load at which any thrust bearing may be run at a given speed, and it is established that the higher the speed the lower the maximum load that can be carried. From this, it may be inferred that there is an absolute limit of speed at which any bearing may be run; namely, when the permissible maximum and minimum loads coincide.

* * *

FALSE EDGE ON CUTTING TOOLS

BY WILLIAM S. ROWELL[1]

Frank Richard's analysis of the action of cutting tools in the June number of MACHINERY is interesting, but does not seem to be final. The writer would like to hear from someone who has studied tool action with special reference to the formation of a new edge (shall we call it false edge?) on cutting tools almost as soon as cutting begins.

Though all observing men in the shop have noticed this action since their first metal-cutting experience, it is much more in evidence today than before the introduction of high-speed steel. It may also be noticed that lathe-men grind their tools with far more top rake than was the custom when slower speeds were in use; is this to provide a less abrupt curling of the chip? This false edge forms on drills and other

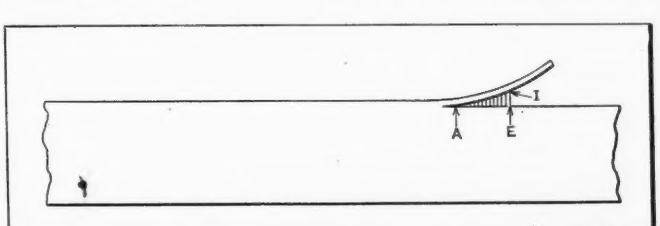

Fig. 1. Cutting Action of Steel

tools almost instantly in many cases; it may be seen where the cut is intermittent or where it is alternately deep and shallow. It is the writer's belief that this edge, in many cases, changes its form slightly while in action, and that it actually comes as near cutting as metal-cutting tools usually do. High-speed steel tools are peculiarly active in forming a false edge; in fact, it would almost seem that one is rarely in use without that curious addition to its edge. This is probably the reason that high-speed steel is of little use for finishing tools.

The writer's theory of the formation of the false edge is that the chip is torn from the work, and in tearing parts slightly ahead of the tool edge. The edge then trims off the rough surface left in the tearing and the minute particles of metal trimmed from this rough surface are imprisoned and compressed in the space *IAE*, Fig. 1. This addition to the tool is much harder than would be expected; so hard that its irregularities impress themselves on both chip and work. A proof of this is the hair-like curled shavings, shown in Fig. 2,

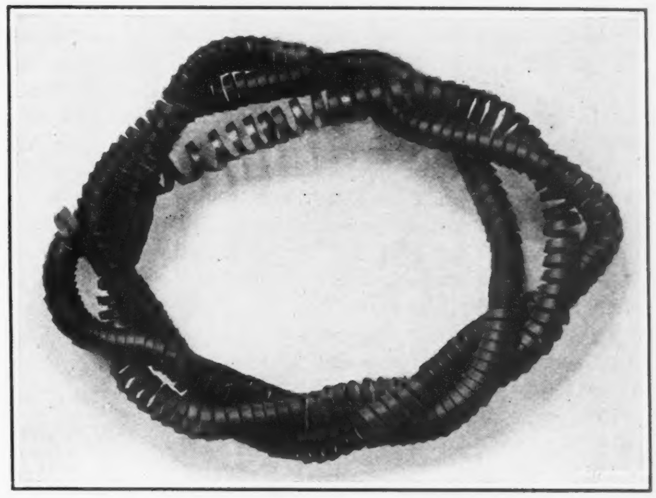

Fig. 2. Effect of varying Rate of cooling a Lathe Chip

formed while turning high-speed steel with a high-speed steel tool. The cutting conditions were normal for a 16-inch lathe removing 1/4 inch diameter from 1 1/4-inch stock. But for a short time these perfectly straight helices were split from the chip near its inner edge apparently by some slight projection from the false edge.

This false edge prevents the formation of a smooth surface, but appears to help in the removal of the chip. The action is similar to that of a tool with a slight cutting angle and much top rake, and the chip is curled slowly. One may often note, in lathe work, the effect of false-edge action on the surface of the work in the form of a regularly repeated building up and partial breaking away of the false edge. When built up to its maximum, the work surface begins to roughen and its diameter to diminish slightly, thus showing that the false edge overhangs the tool proper. This goes on until it is too weak to stand the pressure, when it crumbles away and a smoother surface and normal diameter are again produced. This cycle is repeated with singular regularity in some cases, the resulting work surface being regularly alternating bands of fairly smooth and rough surfaces. In the direction of tool traverse, the roughness appears gradually and changes abruptly to smooth. No one would suppose that opening *IAE*, Fig. 1, is as large at the beginning as the accumulation of false edge is after the first few seconds of cutting. It rather seems that this accumulation starts infinitely small and the metal opening ahead of it gives it a chance to grow; but in growing it becomes weak and crumbles, resulting in a constant slight change.

The chip reproduced in Fig. 2 shows interesting variations in color. The different colors were produced by blowing on the shaving as it left the work; the light colored parts are the sections that were cooled by being blown on, and the dark parts are the sections that cooled slowly.

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* * *

The back yards of some manufacturing plants are filled with piles of rusting scrap that are both unsightly and wasteful, and are permitted to remain in this disgraceful condition. Light sheet metal and wire scrap rust rapidly and lose a large percentage of value in a few months. In these times of high scrap prices and general need of all available metal, it is deplorable to let large quantities of valuable scrap waste away in unsightly piles. The careful manufacturer is known by the back yard of his plant; he will not permit an accumulation of piles of waste materials even if they represent comparatively little value. They reflect disorderliness and wasteful methods, and are an eyesore. This is no time for waste, and disorderliness is always out of order.

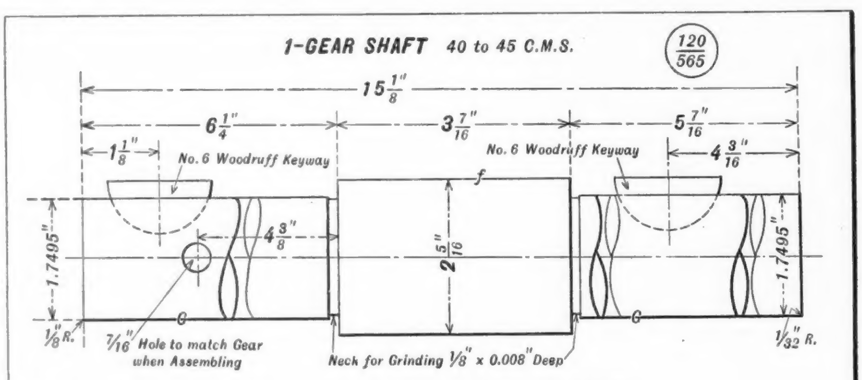
PRODUCTION MANAGER'S GUIDE AND SELF-SCHEDULING WORK

CHART THAT RECORDS PROGRESS AND COST OF WORK

BY ROBERT A. ENDEBROCK [1]

IN these days when progress depends so much upon individual and organized efficiency, we have probably organized societies of every branch of the industrial world except that branch pertaining to the production and routing of parts in process. The American Society of Mechanical Engineers frequently has papers referring to this important work, but until some individual, or group of individuals, organizes the American Society of Production Engineers, men interested in this work must be content to learn from one another by contributing to the various trade journals which have, thus far, given them their most liberal support.

Order and system must prevail if we expect to be constructive and approach our goal, and system comes closer to scientific management when production is increased by the use of simple rather than elaborate methods. The routing system here described compiles in one simple comprehensive chart the routing and tracing of work, location of parts in process, time of each operation on each piece, total time and labor cost for each piece, and the time and labor cost of each department for the lot when it is finished. The chart (see Fig. 2) gives the name of every piece, number required for one machine, piece number, drawing number, schedule number, material issued, the departments through which each piece will pass, and total time and cost columns. The number of the lot and the number of machines in the lot are noted at the top, while at the bottom space is provided for totaling the time of each department, as well as for totaling the cost of all parts, giving the total labor cost for producing the parts for the entire lot. The number in the schedule column denotes the order in which the different parts are to be machined. Parts needed first in the assembling department, those requiring considerable machining time and all hardened parts are marked 1, those of next importance are marked 2, and those of least importance, requiring very little machining, are marked 3 or 4. In the department columns, the large figure denotes the number of the operation and the small figure to the right denotes the estimated time for that operation. The guide chart furnishes just the information the supervisor of production wants, and the ease with which it can be read enables one to gather facts quickly and accurately. Another good feature is that all the detail parts for each unit are grouped together; that is, all the parts for the head are listed together and all the parts for the gear-box are listed together, etc. This enables one to determine quickly which parts of any unit the material has been issued for and how fast they are moving.



DEPT.	OPERATIONS	JIGS AND TOOLS	SCHEDULE NO.
9	TURN FOR GRIND, CENTER BOTH ENDS AND CUT OFF.		1
6	NECK FOR GRIND	167-168-169	
17	INSPECT		
5	MILL KEYWAYS		
17	INSPECT		
11	GRIND		
17	INSPECT		
2	STOCK		

Fig. 1. Drawing that accompanies Work through Departments

Fig. 1 shows a copy of the work drawing, which travels with the work. On the work drawing is shown the piece to be machined, the number required, piece number, operations and schedule number, which corresponds with the schedule number on the guide chart. Putting the schedule number on the work drawing does away with the uncertain and unsatisfactory method of setting due dates and keeps the work moving through the shop automatically in the order in which it is required by the assembling department. It also relieves the foreman of the responsibility of selecting the work and prevents the work from going through in a hit-and-miss manner, because what one foreman may consider as the part that is needed first the foreman in the next department may consider as being needed last. Relieving the foremen of this responsibility gives them more time for instructing their workmen and also for improving the methods of machining, thus obtaining a larger output. If the operator, whether skilled mechanic or apprentice, has several jobs around his machine at one time, he naturally machines the parts in the order in which they are scheduled.

The manner in which the foregoing is applied can be easily followed by taking one part on the schedule. The chart shows that the lot is No. 42 and contains thirty machines. As there is one piece 120/565 required for each machine, the stockkeeper issues material for thirty pieces on May 15, as indicated in the Material Issued column; this entry also shows that the department which has the first operation to perform received the material on that date. When an operation is finished, the date is stamped by the timekeeper in the column of the department in which the operation was finished. In this instance, the first operation was finished in the lathe department on May 21, which entry also indicates that the parts were at that time delivered to the milling department, which had the second operation to perform.

The guide chart shows the estimated time for machining one piece on the first operation to be forty minutes. This time multiplied by the number of pieces required for the lot gives the estimated time for machining the thirty pieces, which is twenty hours. The length of time these parts were actually in this department can be ascertained from the date the material was issued and the date the operation was stamped finished. In this instance, a twenty-hour job remained in the department six days. After the lot of machines is finished, the guide chart is sent to the office and the time for each operation is entered. The time for machining any piece complete is easily determined by totaling the individual operation time from left to right and the total time for each department is obtained by adding the individual operation time vertically.

The following summary shows what information the production manager can obtain from the guide chart:

Name of piece, number required, piece number, drawing number, and which assembled unit each piece is for.

Order of operations.

Time for each operation.

Total number of hours required in each department for each machine to be produced.

Length of time parts should remain in each department, obtained by multiplying time for each operation by number of parts in lot.

[1] Superintendent, Acme Machine Tool Co., Cincinnati, Ohio.

3¼"x 36" FLAT TURRET LATHE					DEPT. 2	DEPT. 3		DEPT. 6		DEPT. 4		DEPT. 7		DEPT. 5		DEPT. 11		DEPT. 15		DEPT. 16		DEPT. 17		TOTAL TIME AND COST PER PIECE	
Head Details	Lot 42.	Amt. 30			Material Issued	Casting Clean	Time taken	Lathe	Time taken	Plane	Time taken	Drill	Time taken	Mill	Time taken	Grind	Time taken	Vise	Time taken	Harden	Time taken	Polish	Time taken	Time	Cost
Name	No. Req.	Pc. No.	Drg. No.	Schedule No.	ORDER OF OPERATIONS WITH PREMIUM TIME																				
Gear Shaft	1	$\frac{120}{565}$	D3514	1	MAY 15 1917			1 40M MAY 21 1917	30M					2 5M MAY 22 1917	7M	3 20M MAY 25 1917	15M							52M	$
Head Fingers	2	$\frac{2}{502}$	F115	1	MAY 17 1917							2 5M MAY 23 1917	5M	1 25M MAY 21 1917	20M			3 MAY 25 1917		4 MAY 28 1917		5 5M MAY 29 1917	5M	30M	
Disk	1	$\frac{2}{518}$	F2892	3	MAY 14 1917	1 5M MAY 17 1917	4M	2 8M MAY 21 1917	6M															10M	
Screws for Spindle Collar	2	$\frac{2}{519}$	F3626	1	MAY 15 1917			1 4M MAY 18 1917	4M					2 2M MAY 19 1917	1M			3 MAY 22 1917		4 MAY 25 1917				5M	
Key	1	$\frac{120}{609}$	F3664	2	MAY 15 1917							3 4M MAY 22 1917	2M	3 12M MAY 17 1917	9M			4 MAY 23 1917						11M	
Pin for Shoe $\frac{120}{80}$	1	$\frac{120}{616}$	F3785	3	MAY 15 1917			1 2M MAY 16 1917	1M			2 1M MAY 16 1917	1M									3 2M MAY 18 1917	3M	5M	
Pin for Shoe $\frac{120}{82}$	1	$\frac{120}{617}$	F3786	3	MAY 15 1917			1 2M MAY 16 1917	1M			2 1M MAY 16 1917	1M									3 2M MAY 18 1917	2M	4M	
Front Cap	1	$\frac{120}{2}$	E3017	1	MAY 14 1917	1 30M MAY 18 1917	20M			2 50M MAY 25 1917	35M	3 20M MAY 26 1917	15M											70M	
Rear Cap	1	$\frac{120}{3}$	E3018	1	MAY 14 1917	1 25M MAY 19 1917	20M			2 40M MAY 23 1917	30M	3 15M MAY 25 1917	10M											60M	
Gear Shaft	1	$\frac{120}{575}$	E3523	1	MAY 15 1917			1 25M MAY 19 1917	22M					2 5M MAY 22 1917	3M	3 15M MAY 24 1917	13M							38M	
Gear Shaft	1	$\frac{120}{576}$	E3524	1	MAY 15 1917			1 15M MAY 18 1917	10M					2 20M MAY 21 1917	15M	3 10M MAY 23 1917	12M							37M	
Bearing Cap	1	$\frac{120}{70}$	E3405	1	MAY 14 1917	1 20M MAY 18 1917	18M			2 15M MAY 22 1917	20M	3 10M MAY 24 1917	10M	4 3M MAY 25 1917	2M									50M	
Bearing Cap	1	$\frac{120}{71}$	D3491	1	MAY 14 1917	1 10M MAY 17 1917	13M			2 10M MAY 21 1917	12M	3 8M MAY 23 1917	5M	4 3M MAY 24 1917	5M									35M	
Driving Shaft	1	$\frac{120}{559}$	D3521	1	MAY 15 1917			1 60M MAY 19 1917	50M	5 10M MAY 29 1917	10M	3 5M MAY 24 1917	7M	2 20M MAY 23 1917	23M	4 20M MAY 26 1917	15M							105M	
Collar for Stop Rod	2	$\frac{120}{611}$	F3638	3	MAY 15 1917			1 6M MAY 29 1917	5M									2 MAY 31 1917						5M	
Department Time							75M		129M		107M		56M		85M		55M						10M	517M	
																						Machinery		8 hrs. 37M	$

Fig. 2. Production Manager's Guide Chart, by Means of which the Progress of the Work and the Cost can be easily followed

Each department's time compared with the department's time of lots previously finished.

Kind and amount of additional equipment required for a specified output, based on number of hours required in each department to produce one machine.

Location of various departments to eliminate unnecessary trucking, determined from order of operations.

Location record of every piece in progress.

Which parts are started, not started, finished and unfinished.

Which parts move forward each day.

Distance each part travels from start to finish.

Number of operations finished in each department each day.

Checks purchasing of raw materials.

Rapidity and order in which raw material is issued to machine departments.

* * *

DESTRUCTIVE VIBRATION IN MACHINES

BY A. SEARLES [1]

We often read of the dire effect that might be produced on a bridge by a "fiddler" endowed with enough patience and physical endurance to induce, in the structure, sufficient vibration to cause ultimate failure; also, that an army marching over a bridge should break step in order to avoid deleterious vibrations, constant recurrence of which may cause crystallization and ultimate failure of members. Again, we read much of the effects of vibration from running machinery on steel and concrete framed buildings, and how these vibrations may be damped to avoid the inevitable collapse of the building. So much for the troubles of those responsible for the bridges and buildings, but let us look into the effects of vibration on machinery. Here, vibration may cause fatigue and rupture in members under stress; it may cause wear in joints or bearings; and it may cause fracture and wear in parts under comparatively insignificant working stress. The effect of all vibration is that of a succession of blows, and it is that into which vibration resolves itself.

Considering first the case of a member under tensile stress, a tie-rod for instance, supported only at the ends, the stress produced can be calculated by determining the deflection, and the resultant stress may be found by calculating the amount of elongation. This condition, of course, is assumed on the basis of absolute rigidity of the member, or members, that undergoes the compressive reaction and stresses within the elastic limit. The formula for the stress in a catenary uniformly loaded is:

$$S = \frac{wl^2}{8D}$$

where w = uniformly distributed load per unit of length;
l = length;
D = deflection.

An analysis of this formula will give some idea of the enormous stresses that may be produced by vibration, especially of small amplitude. These high stresses, coupled with high frequency, may soon produce a crystallized condition, with resulting failure.

The resistance of the member to bending, if sufficiently great, however, may overcome the tendency to vibration. For this reason tie-rods subject to vibration of a serious nature should be supported frequently throughout their length or should be of sufficient rigidity to resist vibration. The stretching of bolts also comes under this class, and if bolts are permitted to become loose, the nuts may work off or destroy their threads. Lock-nuts are not a sure remedy. Even lock-washers, while apparently as suitable as any locking devices, will not obviate the difficulty entirely. This is shown by the necessity for the railway repair gang to inspect each joint periodically and tighten the bolts which are secured by lock washers.

In the case where vibration produces wear in the joints and bearings, we have the direct effect of impact. Since the force of a blow is proportional to the travel of the member producing the blow, it is necessary to maintain minimum clearances and to use materials capable of resisting, as much as possible, permanent deformation. Of course, while materials and construction permitting proper resilience might cure the evil, it is oftentimes impracticable to resort to such means, with the result that the next best remedy must be applied. This is admirably illustrated by the present-day tendency in rolling-mill spindle construction. The older practice was to use rough-cast spindles and couplings, with resulting large clearances. These not only produced excessive wear on the parts immediately concerned, but also produced excessive vibration in other parts of the mill. As a result, the cost of maintenance of the equipment as a whole was greatly increased and the production was affected through lost time incurred by repairs. The more recent practice is a construction that permits the machining of the spindle and coupling joints, thus reducing the clearances. The same trend is being followed in rolling-mill gear-drive practice for the same reasons. Where it was formerly general practice to use cast gears, with their attendant evils on account of the necessarily large clearances, there is a growing tendency toward the use of cut gears.

Numerous interesting results have come to the writer's attention through an extended experience with stamp mills, toggle swagers, and vibrating screens. In the case of one type of stamp mill, which weighs approximately six tons and strikes 1300 blows a minute with stamps weighing approximately 150 pounds and dropping five or six inches, the hammer shafts wear, purely from the effects of vibration in their guide bearings, from an original diameter of 2½ inches down to 1½ inch. Cam-shafts in babbitted bearings soon pound out the babbitt linings, and plain cast-iron bearings give much better results. Originally, open-hearth cut steel gears of ½ diametral pitch, twenty-four teeth, three-inch face, were used to transmit approximately one horsepower, with the result that the teeth rapidly wore to a knife-edge and frequently broke. When these were replaced by rough cast gears of 1¾-inch circular pitch, twenty-one teeth, and six-inch face, the gears wore almost indefinitely. While this result is apparently contrary to past statements, it is possibly explained by the superiority of cast iron operating under these conditions. It might be mentioned that these gears ran at a speed of only eighty revolutions a minute. The superiority of cast-iron gears is also shown in rolling-mill practice, where it has been found that cast charcoal-iron pinions are superior to those of cast steel, both of which have cast teeth.

That excessive wear can be produced by vibration only is shown by the case of a one-inch shaft, eighteen inches long, that supported, aside from its own weight, a part weighing not over ten pounds. This part was supported in cast-iron bearings, 1½ inch long, and was infrequently operated, yet it soon wore into an elliptic section approximately ¾ by 1 inch. At the same time the bearings were worn from ⅛ to ¼ inch out of round.

To maintain tight joints and prevent hammering, some toggle swaging machine makers find it necessary to incorporate springs in their machines. These springs are so applied as to maintain compression on the toggles when the machine is running freely. If these springs become loose or are not adjusted tight enough, the whole machine soon starts on the road to destruction. Bearings pound out, bolts stretch in their threads and wobble, wearing out the threads, and even anchor bolts break, again showing the necessity of keeping close clearances in joints. This has occurred in machines weighing eight or ten tons with moving parts that weigh not more than two tons and consume, on an average, not more than ten horsepower.

As an example of vibration causing the fracture of materials under comparatively insignificant stress, may be mentioned the cast-iron driving pulleys that operated the stamp mill just mentioned. These pulleys were thirty inches diameter, had a six-inch face, transmitted two horsepower, and were run at a speed of eighty revolutions a minute, yet they were soon fractured and had to be replaced by paper pulleys.

Because of the necessity of providing for vibration, the experienced designer does not proportion his machine elements too close to the calculated working stresses. This provision is especially necessary when the duty of the machine is such as to produce vibration to any great degree. Also, it is desirable to provide the maximum flexibility and resilience in the proper place, to absorb vibration compatible with practical results; this is the foundation of success in the design of agricultural machinery and the modern automobile.

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MASTER WHITWORTH THREAD GAGES

BY W. T. ILER, JR.[1]

Thread gages with the Whitworth form of thread are the most difficult thread gages that the toolmaker is called upon to make. The Whitworth thread has seven elements, an error of 0.0002 inch in any of which will cause the gage to be rejected. These elements are the full or outside diameter, the core or root diameter, the effective or pitch diameter, the pitch, the angle, the form at the top of the thread or crest, and the form at the root of the thread.

The first step to be taken when making Whitworth master thread gages is to determine the maximum diameter, the pitch diameter, the root diameter, the size of wires used for measuring by the three-wire system, the dimension measured over the wires, the single and double depth of the thread, the radius at the top and bottom of the thread, and the distance between the sharp point of a 55-degree thread and the top of a thread properly rounded, which is equal to the amount that the tool point is shortened in order to obtain the proper radius on the tool. Fig. 1 shows a master Whitworth thread gage with dimensions as given to the gage-maker. In this case, the

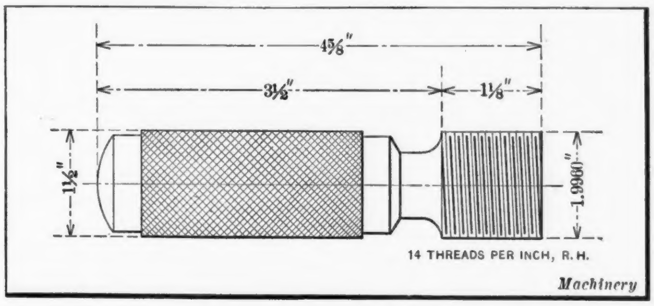


Fig. 1. Thread Gage to be made

full or outside diameter is 1.9960 inch. The diameter of the rough blank is made a certain amount larger, this amount being equal to about twice the radius at the top of the thread.

When measuring a Whitworth master thread gage, two sizes of wires should be used, one of larger and one of smaller diameter. In this way, it is possible to obtain a check on the angle of the thread. The sizes of the wires may be obtained as follows:

$$\text{Diameter of small wire} = 0.52 \times \text{pitch}$$
$$\text{Diameter of large wire} = 0.78 \times \text{pitch}$$

To obtain the dimensions measured over the wires, use the formula given on page 1032 of MACHINERY'S HANDBOOK, modified as follows:

$$\text{Diameter over wires} = D - \frac{1.600825}{N} + (3.16567 \times d)$$

in which

D = full or outside diameter of gage;
N = number of threads per inch;
d = diameter of wires used.

The root or core diameter is obtained from the formula:

$$\text{Root diameter} = D - \frac{1.28066}{N}$$

in which D and N denote the same values as in the preceding formula.

The depth of the thread, radius and double depth of the thread may be obtained from the table on page 1004 in MACHINERY'S HANDBOOK.

Probably the most important and least understood matter in the making of Whitworth master thread gages is the making and use of the thread-cutting tools. After the blank has been roughed out, a thread having the correct lead is cut with an ordinary sharp-pointed tool having a 55-degree angle. This thread is not cut quite as deep as required for the finished thread. Tools for cutting the finished radius at the top and root of the thread are then made as follows: A drill with a diameter equal to twice the root or top radius is used to drill a hole in a piece of soft tool steel, as shown in Fig. 2. This piece of tool steel is then cut straight across the diameter of the drilled hole, along line A–A. After this, it is cut to the shape of a thread tool with an angle of 55 degrees, as shown in Fig. 3. The tool is then hardened, ground and lapped. The 55-degree angle and horizontal cutting surface should be lapped. If taken directly from the grinding wheel and used, the angle of the tool may be correct and the radius, which is the most important part in cutting the thread, may be in error, due to deformation during grinding. The length of this female radius tool is not of importance. After grinding and lapping the surfaces of the tool, the radius is lapped to a gage.

[1]Address: Care of Slocum, Avram & Slocum Laboratories, Inc., 531 W. 21st St., New York City.

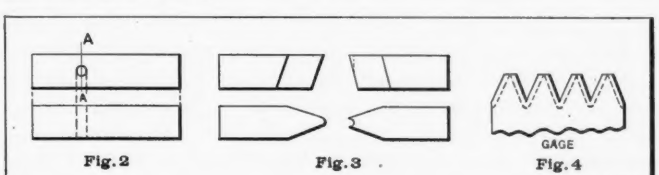


Fig. 2. Blank for Female Radius Tool. Fig. 3. Male and Female Radius Tools. Fig. 4. Thread of Rough-threaded Gage

AMOUNT TO SHORTEN THREAD TOOL TO OBTAIN CORRECT RADIUS

Threads per Inch	Shortening, Inch	Threads per Inch	Shortening, Inch	Threads per Inch	Shortening, Inch
40	0.0040	20	0.0080	10	0.0160
36	0.0044	19	0.0084	9	0.0178
32	0.0050	18	0.0089	8	0.0200
28	0.0057	16	0.0100	7	0.0229
26	0.0062	14	0.0114	6	0.0267
24	0.0067	12	0.0133	5	0.0320
22	0.0073	11	0.0146	4	0.0400

Machinery

The male radius tool for the root of the thread, Fig. 3, is made as follows: A high-speed tool bit is ground perfectly sharp to a 55-degree angle. The bit is then ground and lapped on all surfaces. This is done to make it interchangeable with the female radius tool in the same spring tool-holder. The length of the bit from the sharp point to the opposite end is measured carefully with a micrometer. The accompanying table gives the amount the tool is to be shortened to form the male radius. The amount of shortening is equal to one-quarter of the depth of the thread. The radius is then carefully stoned to size, using the female radius tool as a gage. If the shortening and forming of the radius is carefully done, it ought to require very little further modification to adjust the tool finally so as to bring both the root diameter and the pitch diameter simultaneously to within the limits allowed. The horizontal surface of this tool must also be lapped, for the same reason as given for the female radius tool.

When the gage-maker is ready to use the male radius tool, the gage looks like that shown in Fig. 4. The dotted lines in this illustration show the part cut by the male radius tool.

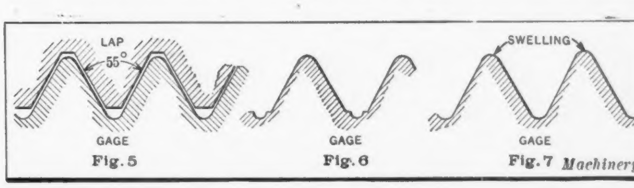


Fig. 5. Lap for Angle of Thread. Fig. 6. Exaggerated Thread Form after lapping Top of Gage Thread. Fig. 7. "Swelling" on Top of Thread

The female radius tool replaces the male tool and the radius of the top of the thread is then cut. All dimensions should be cut to about + 0.0003 inch on a plug gage and — 0.0003 inch on a ring gage. This 0.0003 inch is the amount allowed for lapping.

The next step is to lap the gage to the proper size. This requires four laps. The first is made as shown in Fig. 5. In this lap the angle must be absolutely correct. There need be no top or bottom radius on the lap thread. The root must be cut away so that it does not touch the top radius of the gage. The top of the lap thread should be cut away so that it does not touch the root radius of the gage. The form of the gage thread (exaggerated) after this lap has been used

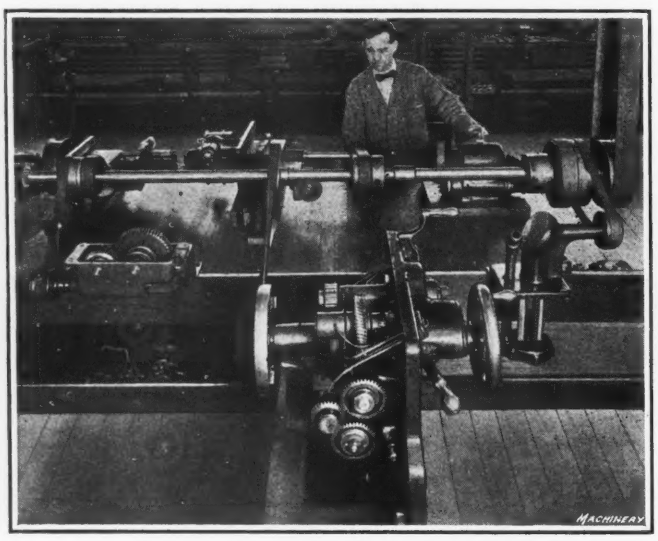
is shown in Fig. 6. The next lap is used to lap the root radius of the gage to size. The angle of the thread of this lap is 54 degrees. The root of the lap is cut away and the top is cut with the female radius tool used in cutting the top radius of the gage. This gives a perfect top radius, so as to lap the root radius of the gage to the proper form and depth. Another lap with a 54-degree angle thread and with a perfect root radius is made by using the male radius tool used to cut the root radius of the gage. The top of the thread of this lap is then cut away. This lap finishes the top radius of the thread of the gage. It will be noticed that the laps, if made as stated above, will lap only one part of the thread at a time. This method will enable the gage-maker to control the various dimensions so as to spoil very little work.

It has been found by experience that after lapping the angles and root radius of the thread, a swelling is formed near the top of the thread by the distortion of the metal, as shown enlarged in Fig. 7. The ridges are removed from the thread by means of a lap cut with a very shallow thread, that is, using the top male radius tool to cut a lap just as deep as the radius of the curve at the top of the thread.

* * *

TESTING BENCH FOR MACHINE UNITS

An important factor in the successful performance of a machine after it leaves the factory is the degree of thoroughness with which the component parts are run in before the machine is finally shipped. With this in mind, the Fitchburg Grinding Machine Co., of Fitchburg, Mass., builder of the Fitchburg "six-twenty" grinding machine, attends to this part of the work by testing the different units of the machine on a special bench like that shown in the accompanying illustration. This view shows six of the units of a grinding machine undergoing the running-in operation before assembling.



Bench for testing Units of Grinding Machines

Referring to this illustration, the units on the rear side of the bench are the work drive gear-box; the table traverse gear-box; the headstock; the cross-feed gear-box on the front side of the bench; the apron; and the lubricant pump. These component units are belted to the drive-shaft, with pulleys to give the correct running speeds, and the inspector goes over them carefully while they are running to ascertain that everything runs right before the machine is finally assembled. In order to make sure that the operation of each unit will be correct under all conditions, the units are run first at the lowest speed and then at the highest speed that will be required in actual operation. If they pass both tests, the units are O. K.'d for assembling. C.L.L.

* * *

The magneto coils for Ford cars are assembled progressively by girls who wind and put each coil in place on its pole as the disks slowly travel past them on a conveyor. The object of the progressive assembly is to set a pace, as each girl must wind a coil and place it in position in order that the sixteen coils shall be finished at the end of the conveyor.

OXY-ACETYLENE WELDING AND THE SCRAP PILE

In ordinary times the scrap pile is the source of a considerable loss of profits. Now that war has pushed up the prices of raw material to unprecedented heights, the American plant owner and factory man have begun to analyze their scrap heaps. They often find huge accumulations of damaged or worn machinery, tools, "short ends" and other material that represents considerable profit thrown away. Face to face with labor shortage, metal shortage and the time factor, plant owners are reclaiming these worn and damaged machines and broken tools and putting them back to work earning profits. Recently an engineer for an oxy-acetylene concern made an investigation in a western mining field. At one large mine he found in the scrap piles, dollies and dies for drill sharpening worth $9 each, which could be welded and put into service at a cost of about $1 apiece. At the same time, the mining company was anxious to get more new material. It was found that the scrap heap would yield a three months' supply of good material in a year's scrap accumulation. At another time the engineer found a year's supply of tram buckets, worth $40 each, with broken bottoms, which could easily be repaired by welding at a slight cost. In addition, he found a three months' supply of stamp stems and short ends of tungsten steel, which could be welded to give a year's supply. He found crusher plates of manganese steel worth $20 each, slightly too big for the machines then in use, but which could be cut down by the oxy-acetylene process at small cost, and put into service again at a great saving. The various processes of welding have made it possible to reclaim a great number of metal machines and tools that formerly were sold as waste, and at a fraction of the original cost. Nowadays any kind of metal—steel, iron, both cast and malleable, brass, bronze, copper, aluminum, sheet iron and precious metals such as gold, silver, and platinum—can be welded and made as good as new. A railroad company had a large accumulation of scrapped driving wheels for locomotives, most of which had cracked spokes. The demand for more rolling stock caused the company to reclaim these wheels, and they were welded by the oxy-acetylene process, saving the road several thousand dollars and yielding much more in profits through putting discarded engines to work.

* * *

COAL GAS AS A SUBSTITUTE FOR GASOLINE

By using coal gas as a substitute for gasoline, English motor bus companies are said to have succeeded in reducing their fuel cost per mile from 8 to 3.3 cents, with gasoline selling at 61 cents a gallon and gas at 61 cents per 1000 cubic feet. The only change made in the motor is the fitting of a butterfly valve in the air-intake pipe for the regulation of the air supply, which allows the engine to draw the gas in the correct quantity according to load and speed. It is claimed that when using gas the engine is cleaner and the valves do not require grinding so often. The gas is drawn from the main into a canvas bag with an inner layer of rubber, shaped like a mattress, which is strapped to the top of the motor omnibus or to the rear of the automobile. This bag is connected with the induction pipe, and the engine is worked by the suction process in the same manner as the ordinary gasoline vapor induction. Because of the bulky container necessary for the gas, this fuel has proved unsatisfactory for small cars.

* * *

Because of the stoppage of tin imports, Germany is reported to have prohibited the use of solder containing more than 30 per cent tin, and the tin so used must have been recovered from dross or scrap. The making of soldered joints is restricted to cases where lapping, riveting, and electric or autogenous welding are impracticable. It is stated that a usable solder can be prepared from ten parts tin, eighty parts lead, and ten parts cadmium. Although the cadmium is three times as expensive as tin, the extra cost is considered of no consequence because of the necessity of using sufficient tin as raw material.

LETTERS ON PRACTICAL SUBJECTS

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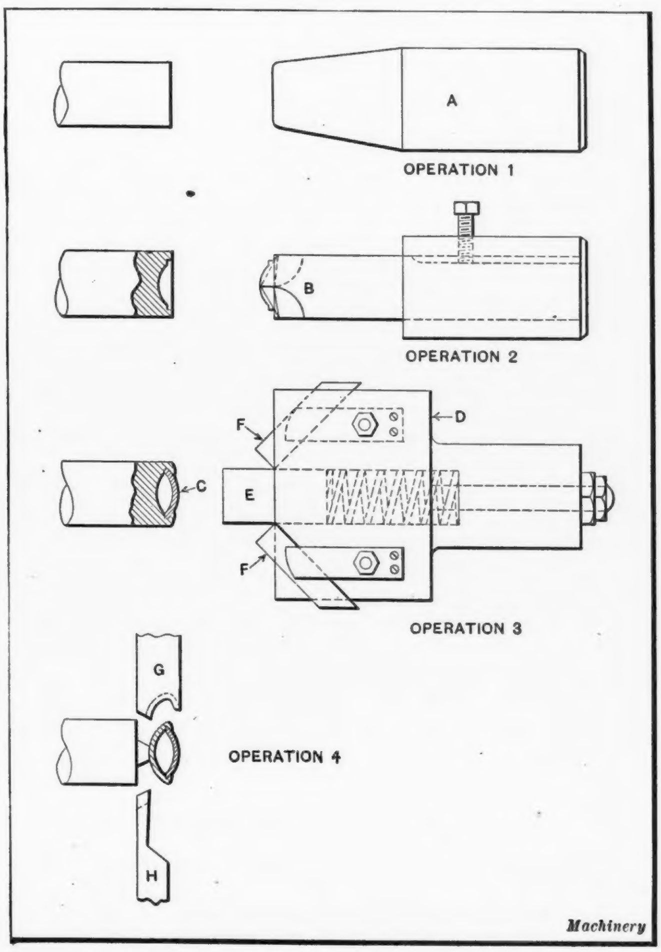
MACHINING EXPANSION SEATS FOR AUTOMATIC SPRINKLER HEADS

In the accompanying illustration is shown a quick and easy method of machining expansion seats for automatic sprinkler heads. These seats are made of 11/16-inch brass rod. To save time on the set-up, two sets of tools can be used in the turret of the screw machine. When a piece is cut off, the stop will be in position for the next piece.

Operation 1—Feed stock to stop; a solid stop *A* can be used, being set about 3/4 inch from the face of the collet.

Operation 2—Cup and face the end of the bar with the combination two-lip tool *B*. Cut the relief about 1/64 inch deeper than the thickness of the sheet-brass disk *C*, which is about 1/16 inch. This disk can be formed and cut out on a punch press in one operation.

Operation 3—Spin disk *C* into place with the burnishing tool *D* shown. The disk *C* is put in place while the machine is in motion and is held there by the plunger *E* while the tools *F* are turning over the edges.



Machining Expansion Seats for Automatic Sprinkler Heads

Operation 4—Form the seat and the round edge with the forming tool *G*. The cutting-off tool *H* should be ground so that no burr will be left when the piece is cut off.

Aurora, Ill. JOHN J. BORKENHAGEN

VERNIER ATTACHMENT FOR MICROMETER

The vernier attachment shown in Fig. 1, which the writer made for his micrometer, while not as accurate as a fixed vernier, is better than the eye for judging fractions of thousandths. It is bored to suit the sleeve of the micrometer and is split to provide enough spring to hold it in place. Lack of space on most micrometers makes a narrow ring necessary. The writer has one 3/16 inch wide and of the same diameter as the thimble, which he always uses when the location of the thimble will permit. A small flat is milled, as shown, on which is a line to coincide with the line on the sleeve of the micrometer; 3/25 of the circumference from this the graduations begin, ten spaces being equal to 9/25 of the circumference. The graduating can be done with a dividing head on a milling machine. The first space will be four turns and twenty holes on the twenty-five-hole circle; the other spaces will be one turn and eleven holes on the same circle. In use, the micrometer is opened to the nearest thousandth of the desired size. Then the ring, having been placed on the sleeve as shown in Fig. 2, is slid up against the thimble and turned so that the lines coincide. Fractions of thousandths may now be read as with micrometers with fixed verniers. A. F. H.

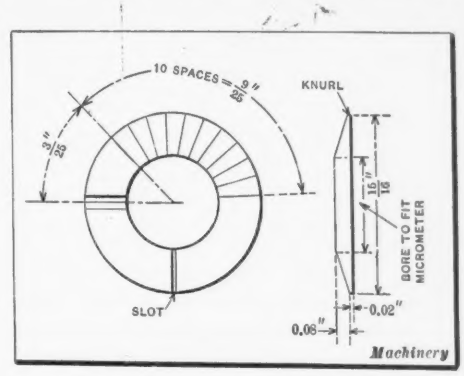


Fig. 1. Micrometer Vernier Attachment

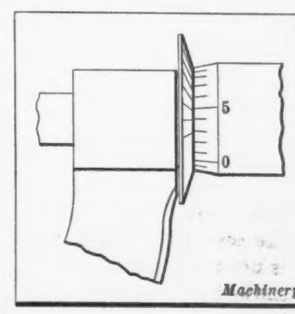
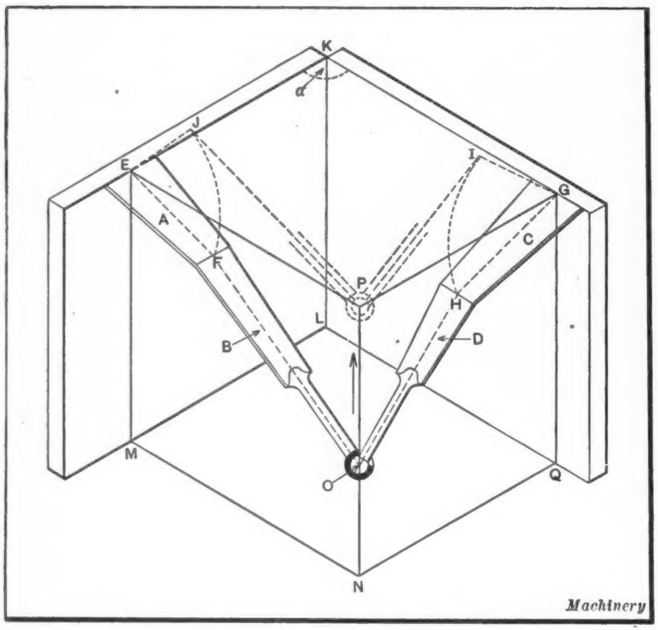


Fig. 2. Micrometer with Attachment in Place

A TWO-PLANE STRAIGHT-LINE MOTION

The linkage known as Peaucellier's exact straight-line motion is composed of seven links with two fixed centers of motion, as described in MACHINERY, August, 1916. If these links are represented by straight lines, the arrangement may be described as a one-plane motion, since all the elements are contained in the same plane. The question naturally occurs: Is it possible to design a straight-line motion having elements in different planes? This result may be attained by four moving pieces with two fixed axes of motion. The figure is an isometric drawing of the combination, which illustrates the simple geometrical theorem that any two planes intersect in a straight line. The planes *EKLM* and *GKLQ* intersect at *KL*, and the moving pieces *A* and *B* are hinged at *E* and *F*, respectively. The broken center line *EFO* (broken at *F*) is constrained to move in the plane *EPNM*, which is perpendicular to the plane *EKLM*. Similarly, the moving pieces *C* and *D* are hinged at *G* and *H*, respectively; and the broken center line *GHO* (broken at *H*) is constrained to move in the plane *GPNQ*, which is perpendicular to the plane *GKLQ*. The pieces *B* and *D* are united by a ball-and-socket joint *O*, the center of which is at the intersection of the center lines *FO* and *HO*. As the center lines *EFO* and *GHO* will remain in the planes *EPNM* and *GPNQ*, respectively, in whatever positions the moving pieces may be placed, the locus of the point of intersection *O* will be at the intersection of the planes containing them; that is, the path of the point *O* will be the straight line *OP*. The broken center lines *EFO* and *GHO* are shown dotted in the positions they reach when the point *O* is at *P*. It



A Two-plane Straight-line Motion

should be noted that the pieces A, B, C and D may be of any length, equal or unequal; that E and G may be in any positions on the lines EK and GK; and that the planes $EKLM$ and $GKLQ$ may be assumed at any angle α.

Hartford, Conn. FREDERIC R. HONEY

DESIGNING A MOVEMENT

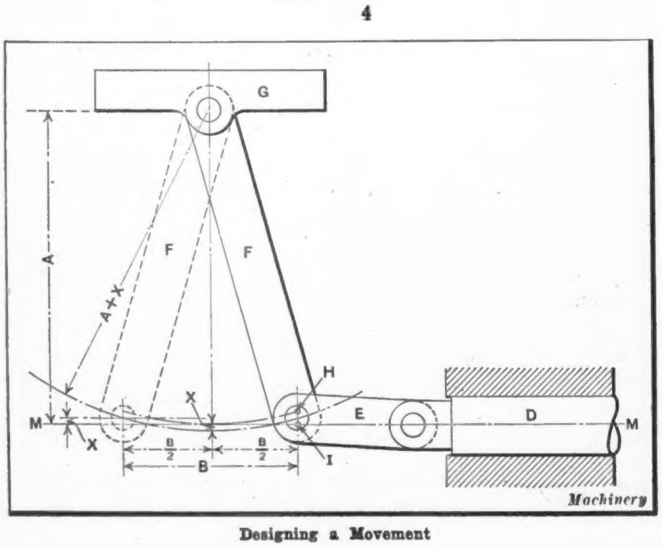
In designing a motion of the type shown in the illustration, it is necessary to have link E vibrate equally above and below the center line MM. A mathematical solution of this problem is not treated in any books the writer has seen. One book that showed a graphic solution added that "the mathematical way is a very extensive process." In the cut-and-try method of the graphic solution, in which X is taken as slightly less than one-half HI, fairly good results are obtained, which, however, are not satisfactory to the mathematical mind. At first the problem looked somewhat difficult, but upon investigation it proved to be quite simple. The quadratic equation becomes one of the first degree, as the solution shows. The parts are as follows: G is the machine frame; F, a lever shown in the extreme positions; E, a link; and D, a slide. The distances A and B are fixed and the problem is to obtain $A + X$, for the required length of the lever. In the right triangle:

$$A + X = \sqrt{(A - X)^2 + \left(\frac{B}{2}\right)^2}$$

Squaring, we have:

$$A^2 + 2AX + X^2 = A^2 - 2AX + X^2 + \frac{B^2}{4}$$

$$4AX = \frac{B^2}{4}$$



Designing a Movement

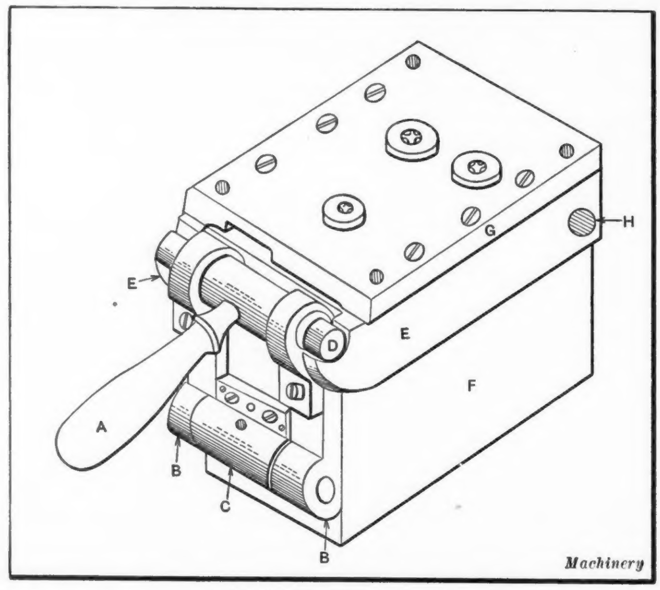
$$X = \frac{B^2}{16A}$$

$$A + X = A + \frac{B^2}{16A} = \text{length of lever.}$$

Prince Bay, N. Y. LOUIS WRAY

QUICK-LOCKING DEVICE FOR BOX JIGS

In the accompanying illustration is shown a handy quick-locking device for box jigs, etc. The handle A is threaded into an eccentric shaft D, which hinges on two straps B. These, in turn, hinge on a support C secured to the front of the jig F. Arms E, fastened to the cover plate of the jig, project beyond the front of the jig to provide a socket for the action of eccentric shaft D. They also give side support to the



Quick-locking Device for Jigs

jig cover and are hinged on pin H. Lever A is pulled up and out to open the cover and given the reverse motion to close it.

E. EDWARDS

SCRATCHING OUT LINES ON THIN PAPER

For one reason or another, drawings are sometimes made on thin paper, such as typewriter paper. If after the lines are inked in, a mistake is found that necessitates scratching out even a short line, it is difficult to make this erasure without making a hole in the paper. If the work of correcting can be left until the drawing is removed from the board, and two or three sheets of the same stock are laid under the drawing before the work of scratching out is begun, there will be little risk of tearing the paper. A sheet of thick drawing paper can be used instead of the extra sheets of thin paper.

Middletown, N. Y. DONALD A. HAMPSON

HEIGHT OF CHIMNEY

In the March, 1917, number of MACHINERY, directions were given for determining the height of a chimney by the old process of measuring the shadow cast upon the ground. While this method of measurement is theoretically correct, there are many practical objections to its use.

Select the most convenient place in sight of the chimney top and erect a short pole, as shown in the accompanying illustration. At a convenient distance from the pole, say eight or ten feet, drive a stake in line with the pole and the chimney; the tops of the stake and the pole may be bluntly pointed. See that both the stake and the pole are plumb. Drive the stake into the ground until the tops of the stake and pole are in line with the top of the chimney, or if more convenient, mark the stake at the point that is in alignment with the pole top and the chimney top. Mark a ground line on the stake level with the ground line of the pole. Measure the distance C from the chimney to the stake, the distance D from the

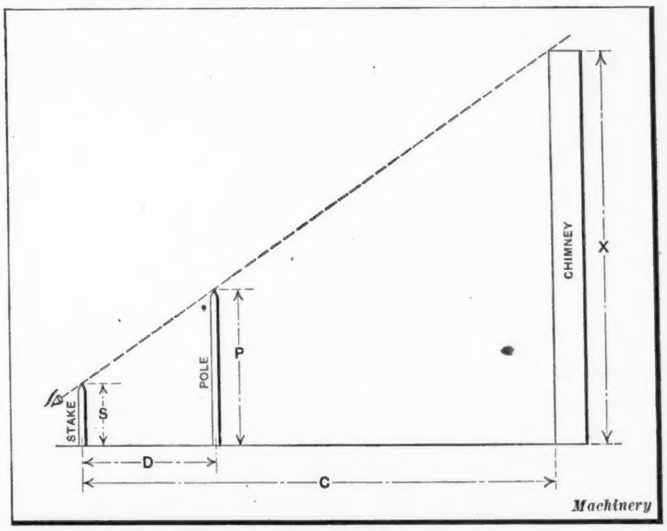
stake to the pole, the height P of the pole, and the height S of the stake. Then the height X of the chimney is:

$$X = \frac{C}{D}(P - S) + S$$

For the formula as given, the ground line at the pole and stake must be level with the base of the chimney. If the base of the pole is above or below the base of the chimney, add or subtract this difference from the calculated height X. If C is 160 feet, D is 8 feet, P is 7 feet, and S is 2 feet, 4 inches, we have, substituting the values and reducing all measurements to inches:

$$X = \frac{1920}{96} \times (84 - 28) + 28 = 1148 \text{ inches} = 95 \text{ feet, } 8 \text{ inches}$$

If the ground line at the pole is 2 feet above the base of the chimney, the total height of the chimney will be 95 feet, 8 inches plus 2 feet, or 97 feet, 8 inches.



Method of finding Height of Chimney

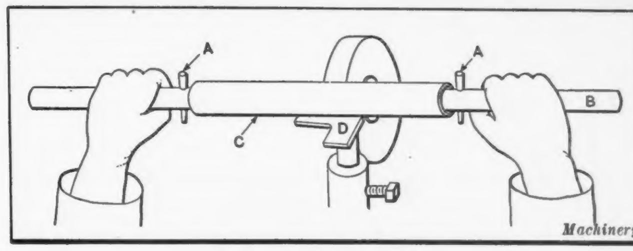
This method will give accurate results that can be verified at any time; it can also be varied to suit conditions. For instance, a mark on the corner of a building will often serve in place of the pole. The measurements may be made on a sloping roof if necessary, taking into account all differences of level.

Barberton, Ohio FRED B. COREY

REMOVING SCALE FROM SHORT BOILER TUBES

A rush job which came to the shop one day was a small vertical boiler that required a set of new tubes. The tubes were very short, less than 18 inches long. So some long used tubes were cut to length by being caught in the chuck of a hollow spindle lathe and the required length of tube cut off with the pipe cutter, an ordinary hand tool being used; the lathe rotated the tube while the pipe cutter remained stationary. The pipe cutter upset the ends of each tube slightly, but enough so that the tubes would not pass through the holes in the tubesheet of the boiler. The burr was filed off a couple of the tubes, but even then they would not go into the holes on account of a thin layer of hard scale. Neither could the tubes be driven in, because the tubesheets would be cut by the scale. As no tumbling barrel was available, the scale was removed by grinding.

At first, one of the tubes was rolled around in front of a water emery grinder, which removed the scale, but it required some time to bring all parts of the tube against the grinder wheel. The apparatus shown was then rigged up, and the set of tubes scaled easily and quickly. Two holes for taper pins A were drilled and reamed in a piece of 7/8-inch cold-rolled rod B, these holes being about 1/8 inch farther apart than the length of the tube C. When the rod had been placed through the tube and the pins inserted, the tube was applied to the wheel of a dry grinder as shown. The tube was placed on a rest D, but so lightly that when the weight of the bar was lifted the grinder wheel caused the tube to revolve slowly. It only required a few minutes for a helper to acquire the knack of holding the bar in such a manner that the tube would revolve slowly against the grinder wheel; then the tube was traversed slowly endwise until it had entirely passed over the grinding wheel. In a short time, the helper was able to remove all the scale during a single passage of the tube past the grinding wheel. The burr was removed at the same time.



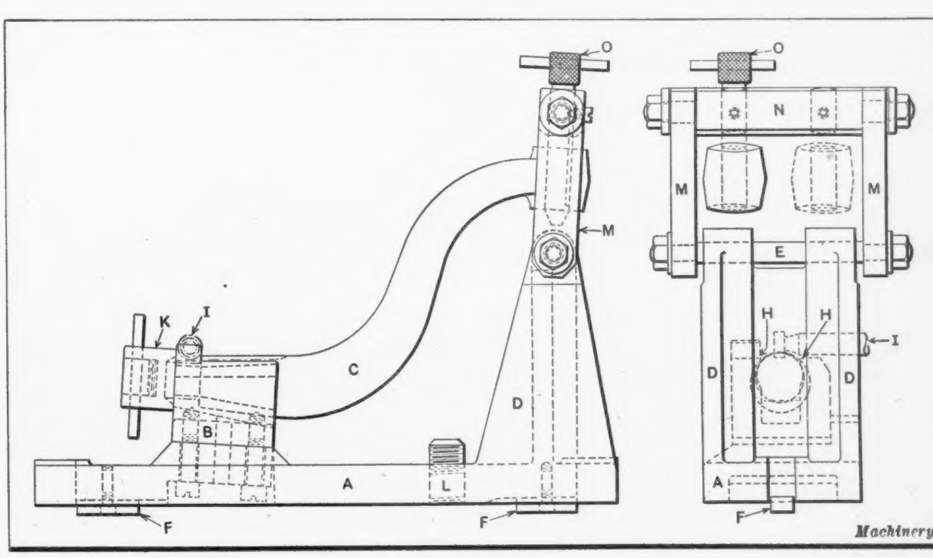
Scaling Short Boiler Tubes

Indianapolis, Ind. JAMES F. HOBART

SPLINING FIXTURE FOR GASOLINE TRACTOR STEERING ARMS

In the accompanying illustration is shown a fixture used when cutting a spline 1/4 inch wide, 1/8 inch deep, and 2 1/4 inches long in the tapered shank of the steering arms of a gasoline tractor. The center line of the spline must lie in a vertical plane through the axis of the tapered shank and parallel to one containing the axis of the hole. The finished faces of the boss and the location of the hole are not required to be accurate, so that the only constant location is the taper. The floating locating device allows the locating plug to float in every direction, but keeps its axis in a vertical plane parallel to the plane containing the axis of the taper. It thus secures the accuracy required without exacting accuracy in the finished faces of the boss or the location of the hole.

The construction of the fixture is as follows: A cast-iron base A, which is clamped to the milling-machine table, provides a seat for the steel piece B in which the tapered shank of the steering arm C is located. It also has two vertical arms D, in the ends of which the rod E carrying the floating locating device slides and rotates. This base is provided with the usual tongues F and screws for fastening it to the table.



Splining Fixture for Tractor Steering Arms

The hardened steel seat *B* that locates the tapered shank of the steering arm is provided with two ground surfaces *H;* the splining cutter *I* is set in position for cutting by placing a 3/8-inch set-block against the larger of these surfaces. Both right- and left-hand steering arms are located in this seat by the tapered part of the shank; a 1-inch groove in the seat provides clearance for the cutter and an outlet for the chips. A hand-nut *K* is screwed onto the threaded part of the steering-arm shank and thus locks the tapered part of the steering arm in the locating seat *B*. This hand-nut is countersunk and its threaded part is only 3/16 inch long; the other part fits over the outside diameter of the threaded shank of the steering arm, thus making it easy to remove and replace rapidly. When this nut is not in use it is screwed upon a stud *L* to prevent it from being lost.

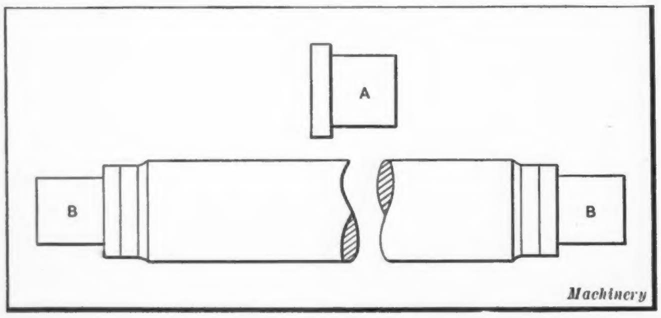
The floating locating device consists of a hardened and ground steel rod *E* that rotates and slides in the bearings in the cast-iron base *A*. The side bars *M* are clamped by nuts and washers to rod *E*, and are reamed to provide bearings for a cross-bar *N* that has two 5/8-inch holes for the locating plug *O*. Plug *O* is used in one hole for the right-hand steering arm and in the other hole for the left-hand arm. Thus the plug is free to rotate about the axis of the cross-bar *N*, and also about the axis of the bottom rod *E*, as well as to move 3/16 inch each way horizontally; yet its axis is always in a vertical plane parallel to a plane containing the axis of the taper. This plug is prevented from being detached from the cross-bar *N* by a screw, which is turned down on the end to a sliding fit in the keyway in the plug. The side arms should be drilled and reamed together so that the center distances of the holes are exactly alike.

In operation, the locating plug *O* is swung back of the fixture out of the way and the tapered part of the steering arm is inserted in the tapered hole in the seat *B*. Plug *O* is then swung into position and pushed into a hole in the boss of the steering arm and the hand-nut *K* is screwed on, thus locking the steering arm in position. One steering arm is splined at a setting. In changing from right-hand to left-hand steering arms, or *vice versa*, the locating plug is transferred from one hole to the other in the cross-bar; this is the only change. This fixture has been the means of avoiding much trouble in manufacturing and assembling, and is a rapid producer.

Hartford, Conn. JOHN J. WOFFINGTON

POWER HACKSAW ON LATHE WORK

The writer had to make several small steel pieces like that shown at *A*, out of bar stock on an engine lathe. To obviate changing tools, both ends of the stock were turned up as shown at *B* with one tool. The ends *B* were then cut



Power Hacksaw on Lathe Work

off in a power hacksaw while turning similar ends on another piece of stock. Of course full-length bars of stock could not be used, as the time and trouble saved in not having to change tools and cutting off in the lathe would be lost in turning the long bars from end to end, but bars from two to three feet long can be handled this way without much trouble.

Worcester, Mass. C. ANDERSON

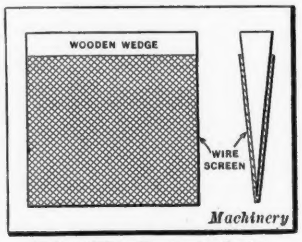
COUNTERSINK SLEEVE

Although the countersink sleeve described in the August number of MACHINERY is satisfactory in certain respects, it has one disadvantage: No matter how tightly the set-screws may be fastened, there is always a tendency for the sleeve to move upward upon the tool if it is brought in contact with the work with any shock. This trouble may be overcome by threading the upper part of the countersink and the sleeve and depending on the set-screw only to prevent rotation of the sleeve. In place of the screw, a thin lock-nut may be used. Tools of this type have been successfully used by the firm by which the writer is employed.

Buffalo, N. Y. CHARLES A. KUHN

FASTENING HAMMER HEADS

The method of fastening hammer heads here shown has proved very satisfactory, and is neater than that described in the May, 1917, number of MACHINERY. Fit the handle to the head in the ordinary way and cut the slot for the wedge slightly wider than usual. Cut a hardwood wedge and bend around it a piece of fine-mesh iron-wire gauze, as shown in the accompanying illustration. Drive the wedge and the gauze in securely and soak the hammer head in water over night. The wood of the handle and the wedge will swell into the mesh, making a good, secure job.



Using Wire Gauze to fasten Hammer Heads

G. E. H.

CUTTING MULTIPLE THREADS

Many devices and methods have been proposed from time to time for the purpose of cutting multiple threads. Multiple faceplates capable of being indexed to various positions have been made and prove useful where much of this work is done. However, these devices are of no avail for multiple internal threading; for this, various methods must be devised for relocating the carriage in relation to the work to obtain the desired result. Where the lathe has a compound tool-block with a graduated dial, it is only necessary to move the compound tool-block into a position at right angles with its normal position, when upon completion of the first cut of a multiple thread the tool can be advanced the correct distance and each thread completed in its turn. This method lends itself to either outside or inside threading. Many lathes, however, are not fitted with compound blocks or graduated dials, so that this method cannot easily be used.

The following simple way of cutting multiple threads can be used on any lathe for either outside or inside threading; it calls for no special faceplates, etc., and is quickly available for an occasional job of this kind. It requires merely a collar to slip over the spindle nose. The width of this collar will be one-half the pitch of the thread on the spindle nose, in the case of a double thread, thus advancing the faceplate or chuck, as the case may be, just one-half turn. When the first thread is completed, removing the collar allows the next thread to locate properly on the work. By the use of two collars triple threads can be cut, one being one-third the spindle-thread pitch in thickness, and the other two-thirds. Assuming a spindle-nose thread of four per inch, the collars would be 0.0834 and 0.1667 inch, respectively; or with a double thread to cut, the collar would measure 0.125 inch in thickness. A perfectly satisfactory job results with ordinary care, and little time is wasted in getting ready to start. F. E. L.

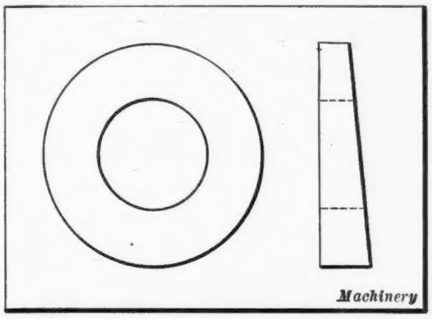
REPAIRING A BROKEN FOLDING RULE

Allow me to take issue with the statement, on page 806 of the May number of MACHINERY, that glued breaks in a folding rule last only a short time. If pianomakers' glue is used, thin and hot, the surfaces to be glued being heated and the pieces clamped together until the glue has set, the wood will break in a new place before the joint will part. One might just as well use flour paste as to use cold glue.

New York City ROBERT GRIMSHAW

TOOLPOST COLLAR

The toolpost collar and shoe ordinarily furnished with an engine lathe has a spherical bearing that allows a wide range of vertical adjustments. While this form has the advantage of very slight adjustments, it is not as rigid as might be desired. The Du Bois toolpost collar and shoe, described in the May number of MACHINERY, having notches on the shoe and the collar, gives a much more rigid hold on the tool, but does not allow the slight adjustments that can be obtained with the plain shoe. In one shop in which I worked, the collars were made plain, and adjusted by inserting shims of varying thickness under the tool. This gave a rigid setting, but necessitated a trip to the tool-room for every lathe job, and where a very small vertical adjustment was required, it was often difficult to find the right combination of shims. To overcome this, the form of collar shown in the accompanying illustration has been adopted. This is simply a plain ring, faced true with the axis on one side and at an angle with the axis on the other. By rotating the collar around the toolpost, the tool can be elevated through its whole range. The bearing of the tool upon the collar is always flat, thus making it very rigid. If a greater range of adjustment is required, a flat shim may be inserted under the tool. A collar of this form allows a wide range of very close adjustments and still holds the tool much more rigid than the spherical form.



Toolpost Collar that permits Close Adjustments

Lomax, Ill. P. H. WHITE

USELESSNESS OF THE INTERMEDIATE MEASURES OF LENGTH

The announcement of the organization of the American Institute of Weights and Measures is pleasing news. Although he has nothing to add to the vast amount that has been written on both sides of the metric controversy, the writer is sure most fair-minded men will agree to the statement that we are not giving the units of weight and measure we now use a fair chance to serve us. Even if we were not threatened by the metric menace, would it not be the reasonable thing for us to use the present units with the least expenditure of mental energy? One glaring example of the worse than useless burden the metal workers carry is the practice of using on the same drawing six binary and one decimal subdivision of the inch, and these seven subdivisions are none too easily translated and compared one with another; they are halves, fourths, eighths, sixteenths, thirty-seconds, sixty-fourths, and thousandths.

Theoretically, the yard is the unit of linear measure; and linear measure only need be considered, as it is the basis of most standards of measure, whether time, weight, or extension. In several kinds of linear measurements, however, the yard is wholly ignored and some multiple or fraction thereof is used, because more convenient. For instance, the wood-worker has adopted the inch in describing sections of lumber. He knows that the inch is the thirty-sixth part of a yard and the twelfth part of a foot, but he never describes a piece of material as 1/18 by 1/6 yard, or as 1/6 by 1/2 foot; rather, he describes this piece as 2 by 6 inches. By so doing, its relation to a 2 by 4 inch piece is instantly seen. How would it be if he were to describe the pieces as 1/18 by 1/6 yard, and 1/18 by 1/9 yard; or as 1/6 by 1/2 foot, and 1/6 by 1/3 foot? In describing a section of timber, the inch is the unit even beyond twelve inches, as the wood-worker speaks of a 2 by 16 inch joist; not a 2-inch by 1-foot, 4-inch joist. In a word the inch, being as small a unit as he is likely to use often in such measurements, is made the unit; just as everyone uses the cent and its multiples in naming values up to a dollar, ignoring the dime, which was undoubtedly intended as an intermediate unit between the cent and the dollar.

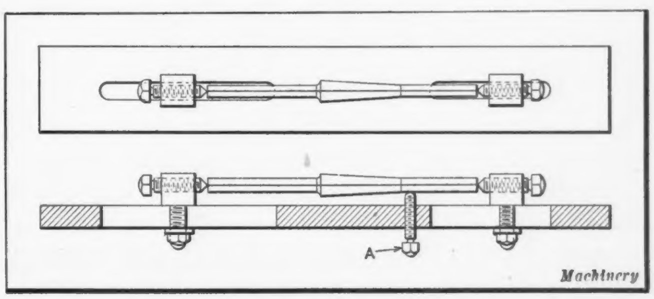
A tool crib of the writer's acquaintance is served by one man, who is often changed. He is always a green man to start with, and his efforts in realizing the size relation between a 5/8-inch drill and a 39/64-inch drill are distressing. Why not decide that 1/64 inch is the smallest unit we are likely to need in designating drills above a certain size and give all sizes below the inch in sixty-fourths? Here, again, the practice of wood-workers furnishes something of a guide. In the old days of heavy framing, augers varied by 1/4 inch and were known as two-quarter, three-quarter, four-quarter, five-quarter, and so one, and today, wood-workers' brace bits vary by 1/16 inch and are marked with numbers indicating the number of sixteenths of an inch each is in diameter. This not only is much simpler, but makes possible the use of larger characters in stamping sizes on the limited areas available. If drills, reamers, and taps were marked in the same reasonable way, what an amount of mark-hunting and eye strain could be saved, not to mention the easily realized relation between a 40/64-inch (5/8-inch) and a 39/64-inch, or a 41/64-inch drill?

Of course drawings should be dimensioned in the same way, possibly thus avoiding part of our many errors in adding and subtracting dimensions. Protests against the use of binary and decimal fractions on the same drawing were published many years ago. The same complication and source of error exists today. Huge wall charts, designed to help translate one into the other, appear at frequent intervals wherever such drawings are in use—everywhere in the metal-working industries in this country. The introduction of decimal fractions in the metal-working industries, while still retaining the partial use of binary fractions, always was, and always will be, the source of endless error and a great progress retarder. In the case of the micrometer we seem to have been far more reasonable. We entirely ignore the chance to introduce fortieths and in almost all cases we forego fourths and halves, naming sizes in multiples of the smallest unit that is frequently used, 0.001 inch. Who can say why we burden ourselves with seven fractions of an inch when one or two would serve much better? Here's for a start at relieving us of part of our present burden; at the same time we take the big stick from the man who would saddle us with more.

Wilkinsburg, Pa. WILLIAM S. ROWELL

STRAIGHTENING HIGH-SPEED STEEL REAMERS

Several high-speed steel reamers about 14 inches long, with a pilot 5/8 inch in diameter and 3 1/2 inches long, were sprung in hardening so that they would not finish to size; so the simple device here shown was made and clamped in a vise close to the hardening furnace. The reamers were heated and placed in position in the fixture; then a little pressure was applied with a screw *A* at the point of greatest error. This device also is used for testing by rotating the reamer on the centers and observing the space between it and screw *A*. The advantage of the device for high-speed steel is apparent, because, after hardening, the steel may be heated sufficiently to correct it without injuring its temper.



Device for straightening High-speed Steel Reamers distorted by hardening

Springfield, Vt. F. H. WHITNEY

WHY DIDN'T IT EXPLODE?

In the August number of MACHINERY, W. S. R. asks why a can of milk did not burst or show signs of escaping steam while immersed in boiling water. The explanation is very simple. There was no steam escaping from the can because the milk did not boil, and the milk did not boil because it was not sufficiently heated. The boiling point of milk is 215 degrees F., and that of water is only 212 degrees F. The bulging of the ends of the can was caused by the contents becoming heated and expanding.

St. Louis, Mo. LOUIS A. SCHLOSSSTEIN

The title "Why didn't it explode?" should read "Why should it explode?" The temperature of the "furiously boiling" surrounding medium was 212 degrees. The pressure due to this temperature is 14.7 pounds, or atmospheric. The temperature in the interior of the can is, therefore, at most 212 degrees and the pressure atmospheric. As the internal and external pressures exactly balance, why should any explosion be expected?

Holyoke, Mass. W. M. FLEMING

The reason the can of milk did not explode is easily given. In the case of all canned foods, the surplus air is exhausted before the small vent hole in the can or cap is sealed. The general method is to place the cans in steam-heated ovens so that the food will expand and force out the surplus air. Then when the cans are sealed and cooled, what air they may contain is below the atmospheric pressure, with the result that if the cans are over-exhausted or underfilled, the sides will collapse. Foods that are packed cold are subjected to a temperature of 160 to 180 degrees F. for from one to three minutes. Foods, like corn and tomatoes, that are partly cooked when packed are packed hot and so do not require the exhausting process.

After the vent is "tipped," or sealed, the foods are sterilized, or cooked, to prevent fermentation and to destroy bacteria. Berries and fruits are subjected to a temperature of 212 degrees F. for ten or fifteen minutes; tomatoes are subjected to a temperature of 240 degrees F. for from twenty-five to forty minutes; while salmon is subjected to this temperature for one hour. Subjecting a can of milk to a temperature of 212 degrees for twenty minutes, therefore, hardly overcomes the partial vacuum in some food cans.

The art of soldering tin cans is known to only about a hundred men in the United States. A No. 3 tomato can will not burst under a pressure of 75 pounds per square inch nor will it spring a leak at 50 or 60 pounds. A No. 2 corn or pea can will burst if subjected to a pressure between 90 and 120 pounds, and a milk can will resist pressures up to 125 pounds, as they are lighter as well as smaller in diameter. This strength is secured in spite of the fact that can makers use less solder in making the whole can than the packers use on the cap alone. Cans are tested with an air pressure of 15 to 18 pounds per square inch under water, and the seller guarantees that not over two cans out of each thousand will leak when filled and subjected to cooking strains, and agrees to pay for the cans, the food in them, and the cost of packing if the leaks exceed that amount—which never happens, even when this nation empties 13,000,000,000 tin cans a year.

Wheeling, W. Va. W. H. BROOKS

BORING A LARGE FLYWHEEL WITH IMPROVISED TOOLS

Modern methods have largely done away with the odd jobs that used to be encountered and that required considerable ingenuity on the part of the machinist. While many of the older men will doubtless recall jobs similar to the one here described, these makeshifts bring out points of interest even to the modern machinist.

A flywheel 12 feet in diameter, and weighing many tons, had to be bored. As no shop in the locality could handle the work, the following method was used: One end of an old piece of shafting was chucked in the lathe, the other end being supported by steadyrests. When trued up, the shaft was turned for a short distance close to the chuck and a 32-pitch thread cut on it, the length of the thread being a little longer than the hole through the hub of the flywheel. About one inch of the shaft close to the chuck was then turned to tap size. This, together with the thread, was polished smooth and the shaft was cut off close to the chuck. A hole was then bored in a hardwood plank to fit the tap size, making a tight fit, and an inside threading tool was run through a couple of times, roughly cutting a 32-pitch thread. Before removing the piece of plank from the chuck, a circle was struck upon it a little distance from the hole; this was used in centering the boring-bar.

This piece of plank was laid between two timbers and suspended below the flywheel; a bearing placed above the flywheel supplied the other bearing for the boring-bar. The lower end of the bar was then centered by measuring from the rim of the flywheel to the circle on the plank and the upper end was centered by measuring to the shaft. The lower bearing was then fastened securely to the floor. A cutter in a collar was placed on the shaft and a lever fastened to a split pulley, which was clamped to the shaft, gave a means for turning the boring-bar. The feed of the bar was derived from the thread traveling through the plank; a clamp prevented the plank from splitting. Three cuts were taken, the first one down, the second one up by reversing the cutter and the direction of the bar, and the third down again. Half a day's work of a laborer supplied all the power required and was cheaper than rigging up for any other source of power.

The balancing of the flywheel was done after it was placed in position. The shaft was raised out of its bearings and rested on large flat bars of steel, care being taken to have them level. Provision for obtaining the balance was made beforehand by casting weights on the inside of the wheel all the way around. These weights were nicked close to the wheel and were easily removed as required.

Scranton, Pa. JOHN H. VAN ARKEL

PAINTING STEEL CEILINGS

The manufacturers of steel ceilings prepare the sheets with a gloss, as follows: After the sheets are stamped, they are dipped in a mixture of zinc white and varnish that has been thinned down with benzine. Not enough zinc white is added to make the finish opaque, though this is not important, since the finish is applied by a painter who prefers a different prime coat, one quite dead or flat. If the steel sheet has not been primed or coated in the factory, the painter must cleanse it of grease and dirt with benzine, or some alkaline solution. When dry, it should be coated with raw or boiled oil to which a little drier has been added. While the makers of steel ceilings use a primer with a pigment base, zinc as a rule, the best primer is the pure oil, raw or boiled. After the oil priming coat has become dry, any desired paint may be applied; usually a gloss paint is used, though many prefer a soft, rather flattish effect.

Galvanized iron should not be painted until it has been subjected to the weather for a year or so, unless it has been treated with a liquid to cut the so-called "grease" or galvanizing. In many instances, new galvanized work looks well enough without paint, in which case it is a waste of time and money to apply paint to it. But when the finish demands the painting of the galvanized work, it may be prepared by giving it a coat of the following mixture: Dissolve in one gallon of soft water 2 ounces each of copper chloride, copper nitrate, and sal ammoniac; then add 2 ounces of muriatic acid. Mix in a wooden vessel and apply with a broad-bristle brush. When dry, the work may be painted.

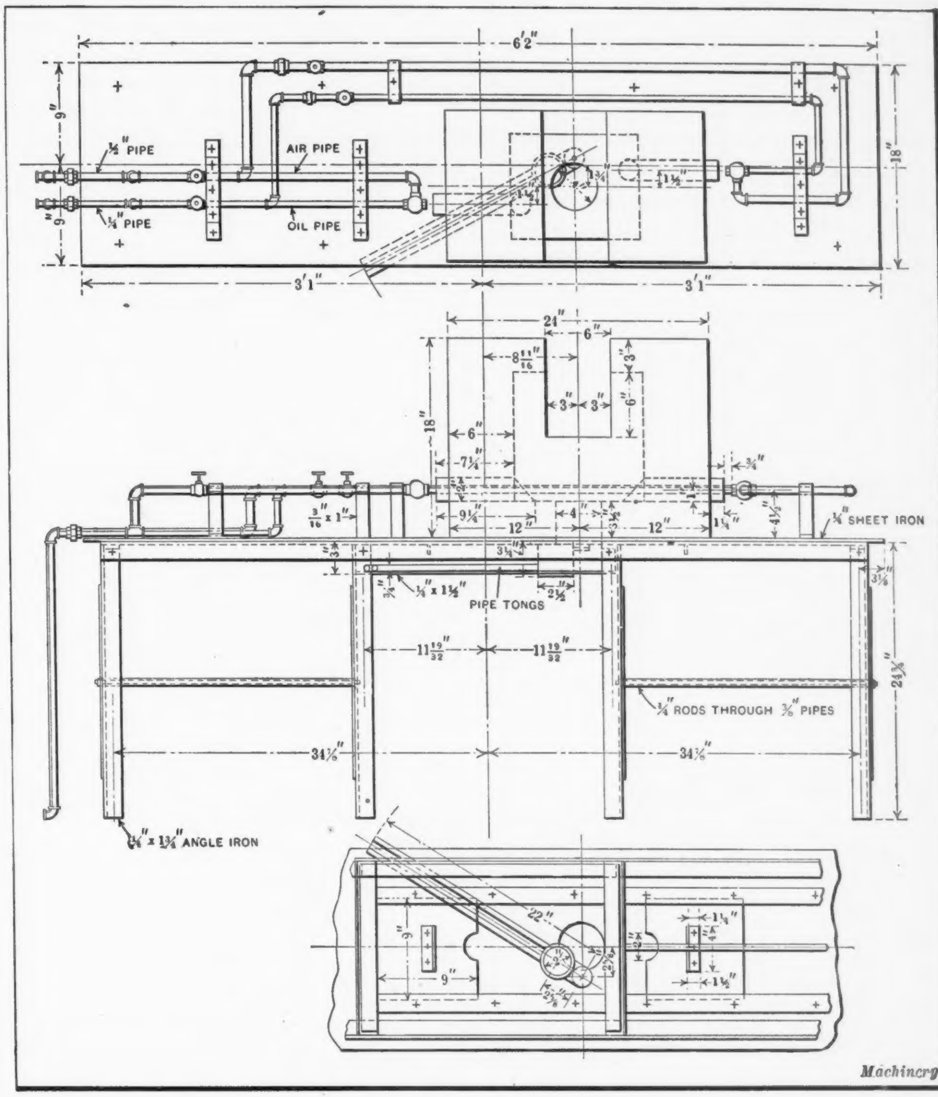
Liverpool, England MARK MEREDITH

BRAZING FURNACE

In the accompanying illustration is shown an efficient brazing furnace with two burners, which heats the pipe all the way around. The top of the supporting table is made of ¼-inch sheet iron, 18 by 74 inches, which is fastened by coun-

tersunk bolts to angle-irons running lengthwise of the furnace. Each leg is made of a continuous piece of angle-iron, and the table is made rigid by 1/8-inch by 1 3/4-inch plates across the legs and by 1/4-inch rods, passed through 3/8-inch pipes, as shown. This furnace will take 4-inch copper pipes, but is used mostly for brazing 2 1/2-inch pipes. As the pipe is placed in a vertical position, the 4-inch hole makes it possible for the pipe to extend below the table top if necessary. Directly beneath the top of the table are two slides, resting on plates running lengthwise; each of these is cut out so that when closed they will make a snug fit around a 2 1/2-inch pipe. Underneath these slides is a pair of pipe tongs, working on a pivot. The ends of the handles are supported by a 1/4-inch by 1 1/2-inch iron plate; the tongs are shown pushed in out of the way. By the aid of these tongs, a pipe can be held at any desired height for the flames to work upon.

The center lines of the two burners are 3 inches apart; this makes a quick heating arrangement and at the same time heats a good portion of the pipe. A 1/4-inch oil line and 1/2-inch air line are run from the tanks to a T near the furnace; from there on, there are two oil and two air lines, one of each for each burner. The piping is supported by 3/16- by 1-inch iron supports, and all valves are placed close together so they can be conveniently and rapidly operated.



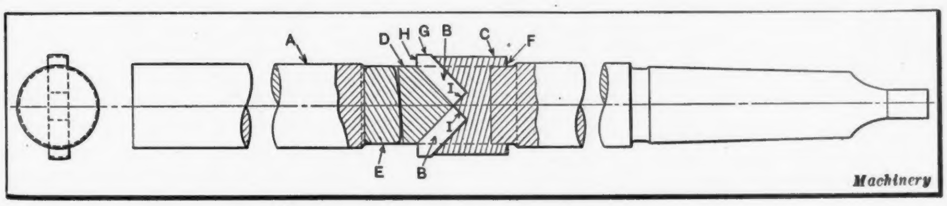
Two-burner Pipe Brazing Furnace

The box is 24 inches long by 13 1/2 inches wide, and is made of 1/8-inch sheet iron, which is lined with firebrick, covered with fireclay. Each side is cut out 6 inches wide and 9 inches deep; the inside is shaped as shown by the dotted lines. A small plate can be laid over the hole in the bottom, through which long pipes are passed to retain the heat when the pipes are laid horizontally or when short pipes are being worked upon. M. K.

SOLID ADJUSTABLE BORING-BAR

The boring-bar of the solid adjustable type here described has given excellent satisfaction. This particular bar is for a drill-press fixture having guide bushings above and below the cut, and the bar is therefore shown with pilot sections above and below the cutters and with a taper shank. However, the same principle can be used for a turret-lathe bar. The cutters *B* are of standard section of high-speed steel, the same as that used for tool-holder bits. The holding piece *C* is a nice fit in the slot in the bar *A* and is centered in the customary manner by being fitted up over a flattened part of the bar at *F*. The cutters are held in place by the piece *D* and key *E*. The edge of key *E* bearing against part *D* is made slightly rounding to take up any inaccuracy in the cutter stock. All parts except the cutters are made of machinery steel and pack-hardened, the pilot sections and taper shank of the bar being then ground. The cutters are ground to size on the surface *G* without clearance, being cleared only from the cutting edge *H*. When the bar begins to cut under size, the cutters can be packed out at *I* and reground. This bar has the advantage of having high-speed cutters without the expense of making them up special. Besides, it ties up the minimum amount of high-speed steel, thus reducing the waste far below that of the ordinary solid or adjustable cutters.

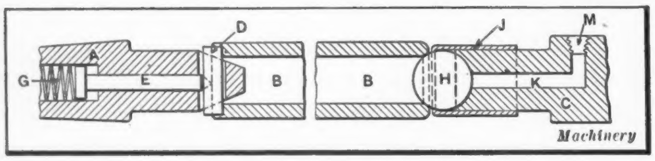
Orange, Mass. W. R. Stults



Solid Adjustable Boring-bar for Drill-press Fixture

TURNING PISTON-PINS

The accompanying illustration shows a method of turning piston-pins in which it is not necessary to stop the machine when removing or inserting the work. By the old method, the pins were turned on ordinary centers at high speed. In the headstock center *A* is a cross-key *D*, which engages a slot milled in one end of the piston-pin *B*. Key *D* is backed by a plunger *E* and spring *G*. The end of the headstock center is threaded for an Allen set-screw, by means of which the spring tension against plunger *E* and key *D* is adjusted. These pins are made from steel tubing, which is rounded and centered on one end and then cut off, rounded and centered on the other end; these operations are performed on Brown & Sharpe automatics. The slot is then milled in the end, after which they are ready to be turned. When turned by the old method, the pins revolved at high speed, causing the tailstock end of the pins to wear rapidly, with the result that they were turned out of round, so that in the grinding operation after hardening,



Turning Piston-pins using Steel Ball on Tailstock Center

many were found that would not "clean up." Another disadvantage of this method was that white lead was used as lubricant, and if it was not all removed from the pins it would prevent the places covered from being properly carburized. Then, too, the tailstock center, after being used a short time, became worn and raised a burr on the inside of the pin, which caused considerable trouble when the pin was ground.

The new method produced a round pin without any burr in the end and entirely eliminated the use of white lead. The special feature of this device was the use of a hardened steel ball *H* revolving with the pin, on the hardened concave end of tailstock center *C*. Ball *H* is held in place by a piece of brass tubing *J*. Cross-holes *K* drilled in the tailstock carry the lubricant to the ball *H* from the grease cup screwed into the tapped hole *M*. By the old method, it was necessary to run one machine day and night to get the desired production; by the new method the production is obtained in ten hours.

Flint, Mich. THOMAS J. ROTHE

RIGHT- AND LEFT-HAND TOOLS

There seems to be a diversity of practice among the different makers of machine tools and lathe tools as to the use of the terms "right-" and "left-hand" and "right-" and "left-bent," with reference to tools and tool-holders. The question may be considered under three heads: First, right- and left-hand tools, with reference to the cutting edge of the tool; second, right- and left-bent tools, with reference to the shank of the tool, which is bent to allow for clearance for different kinds of work; and third, right- and left-hand tool-holders, which ought properly to be called "right-" and "left-bent."

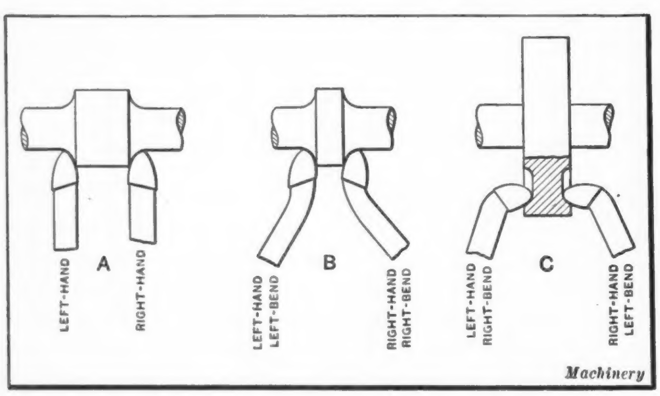


Fig. 1. Names of Commonly Used Types of Lathe Tools

It is the writer's opinion that in machine shop practice it is practically settled that a right-hand tool is one turning toward the headstock, and a left-hand tool is one turning the opposite way, or toward the tailstock.

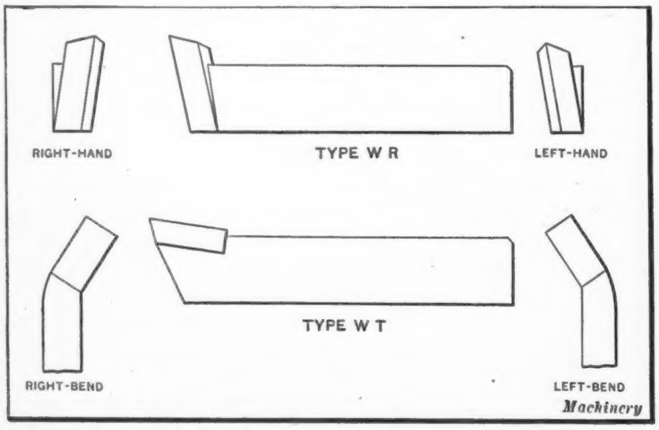


Fig. 2. Welded Lathe Tools made by Ready Tool Co.

There seems, however, to be no general agreement as to the use of the terms "right-" and "left-bent." The writer believes that the majority would call a right-bent tool one with a shank bent toward the right, and a left-bent tool, one with a shank bent toward the left. Fig. 1 shows at *A* a left-hand and a right-hand tool, and at *B* a left-hand, left-bent tool and a right-hand, right-bent tool. These are tools that are commonly used. Tools that are also used a great deal are left-hand, right-bent and right-hand, left-bent tools, which are illustrated in operation at *C*.

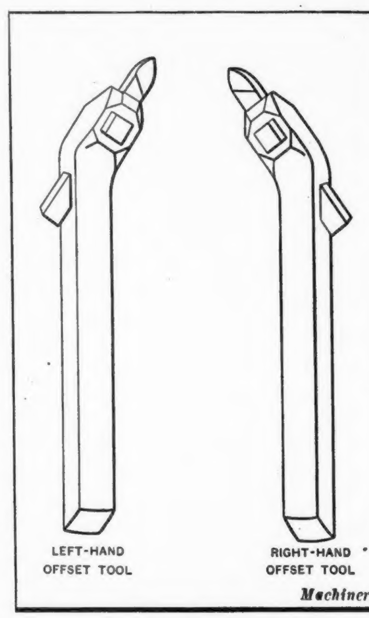


Fig. 3. Offset Tool-holders made by Ready Tool Co.

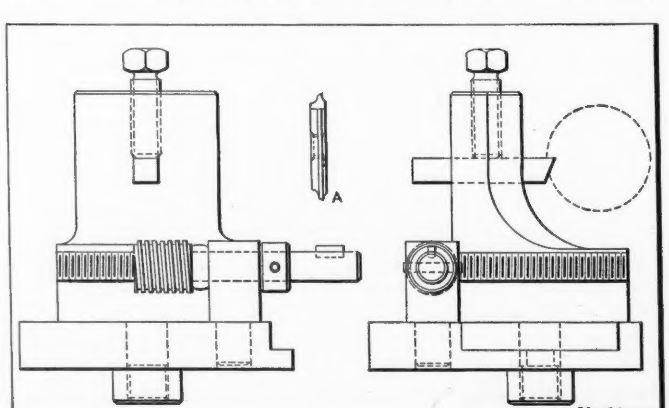
It seems to have been the general custom to designate tool-holders as "right-hand offset" if the shank is bent toward the left, and as "left-hand offset" if the shank is bent toward the right. The only reason that can be seen for this is that a right-hand offset tool, although bent to the left, has the cutting edge, generally, on the right-hand side of the cutter and is used for turning toward the tailstock, or toward the right, while a left-hand offset tool has its cutting edge on the left-hand side and turns toward the headstock.

The Ready Tool Co. has decided to adopt for its welded stellite tool the words "right-hand" and "left-hand" for its Type WR tool, which is a modified diamond-point tool, and the terms "right-bent" and "left-bent" for the bent Type WT tools, in which the stellite is on the top. It is believed that this designation will cover all the various questions encountered and that it would be a great help if these terms were universally adopted.

THOMAS FISH,
President, Ready Tool Co.
Bridgeport, Conn.

RADIUS TURNING FIXTURE FOR MAKING FORM CUTTERS

It was necessary to make twenty-four form, corner-rounding cutters *A* for a Brown & Sharpe automatic screw machine, the corner-rounding grooves being of different radii. As the shop had no regular forming or circular-turning device, the simple mechanism here shown was made. It is adapted for the Hendey lathe tool-slide after the compound slide is removed.



Radius Turning Fixture used in making Cutter A

The blanks to be finished are held on a threaded arbor inserted in the headstock spindle or on a plain nut arbor caught in a scroll chuck. The tailstock is shoved back out of the way, and the tool is fed against the blank by hand, using the crank of the compound rest to rotate the toolpost through the

worm drive. The cutter-holding block is cleared ⅜ inch back of the center of rotation, giving a definite measuring point for setting the tool for a given radius. The tool slot is located at the right position for describing a true circle. Circular cutters with radii from 0 to 1½ or 2 inches can be generated.

Springfield, Vt. O. S. MARSHALL

RADIUS OF SMOKE ARCH

The following is a simple, accurate way of laying out the radius of a smoke-arch fit for a pair of cylinder saddles: Have the carpenter make two templets out of dry ¾-inch boards, making one fit the smoke arch at the front and the other at the back of the cylinder saddles. Obtain the height of the saddle, from those removed or the blueprint, measuring from the frame fit to the lowest point of the smoke arch for the distance *F* and place a center-punch mark *A* at the top point of this distance. Fasten the wooden templets to the cylinder saddle with wooden clamps, making the middle point of the templets coincide with the center-punch mark *A* on the saddle. With a small trammel and any radius and with point *A* as a center, draw arcs cutting the arc of the templets at *C* and *D*. Take any point *B* on the center line of the cylinders and strike an arc to *C*. Then with the trammel and the distance *BC*, check up the distance *BD*, raising or lowering the templet to make the distances *BC* and *BD* of equal length, being careful that the middle point of the templet and *A* coincide. Then scribe off the radius onto both the front and back of the cylinders.

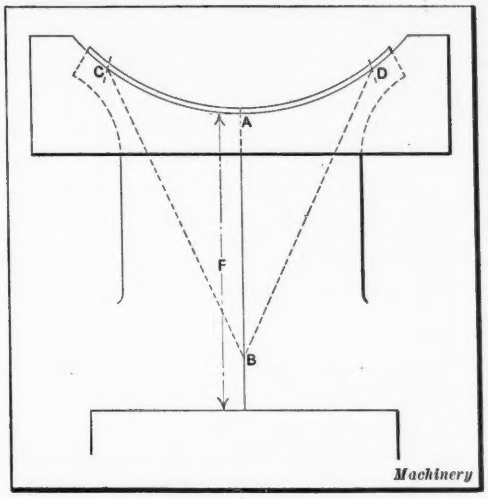
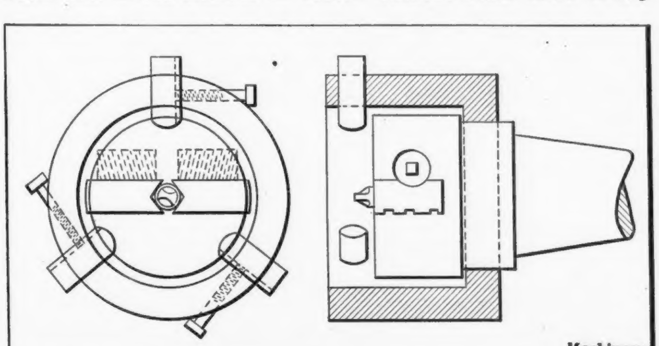


Diagram for determining Radius of Smoke Arch

Scranton, Pa. ERNEST A. KOSCHINSKE

CENTERING TOOL

The accompanying illustration shows a device that has been found quite useful in a shop doing considerable screw-machine work that is too slender to center without some form of support. While made for this class of work, this device may also be used in the lathe where a steadyrest would otherwise be required. As shown it is a cast-iron hood, carrying jaws, that is made a press fit on the body of a drill chuck. The round drawn brass jaws seat in reamed holes in the hood.

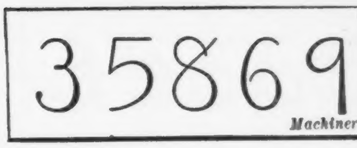


Centering Tool

Cincinnati, Ohio H. M. BOGART

PLAINER FIGURES FOR THE SHOP

The article in the July number of MACHINERY advocating the use of plainer figures on steel stamps used for marking in machine shops agrees with the writer's ideas, but while we are about it, why not cut out the nine that is an inverted six, and why make the three as nearly like the five as possible? In a word, why not give each numeral character and individuality, and make it so distinctive that no figure can be mistaken for any other though standing alone and inverted? Should it not be beyond discussion that each numeral should be as different from all others as possible and still retain the necessary simplicity? It would seem that the only excuse for a three with a horizontal top and a lower curved line that duplicates the same line in a five, is that the three will thus be less likely to be mistaken for an eight; but with such an eight as is shown in the article referred to, there is small chance of the two-cusp three being confused with it. Why not numerals like those here shown?



Plainer Figures for the Shop

Wilkinsburg, Pa. WILLIAM S. ROWELL

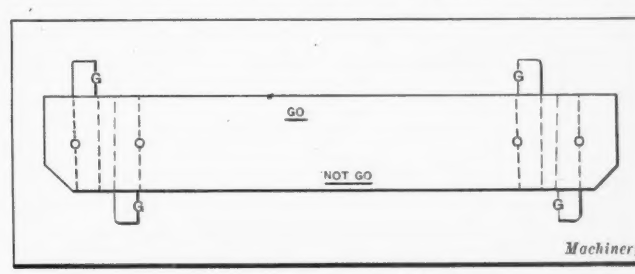
A MICROMETER TIME-SAVER

Most of the Slocomb micrometers, except the 1-inch size, will measure ± 0.100 inch. Hence, if a measurement of 3.075 inches is to be made, it is unnecessary to go to the tool crib to exchange a 2- to 3-inch micrometer for a 3- to 4-inch size, as this measurement may be made with the extra capacity of the micrometer at hand.

Bridgeport, Conn. JAMES MCINTYRE

LIMIT GAGE

The accompanying illustration shows a very simple and inexpensive device for the close gaging of various kinds of large quantities of manufacturing parts. The writer has used it for over two years with the best economic results. It has no complicated parts for machining or hardening. It consists simply of a cold-rolled steel bar and standard Brown & Sharpe taper pins, tool steel, hardened. A worn-out gage can be repaired by replacing one pin and regrinding and lapping the gage.

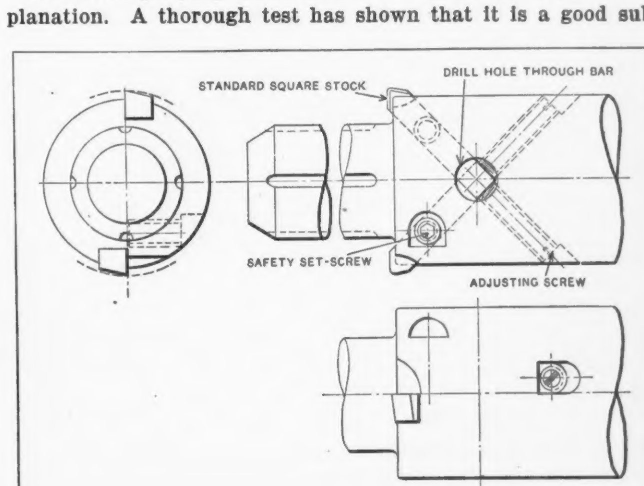


A Simple, Inexpensive Limit Gage

New York City MAX T. VOIGT

BORING-BAR

The accompanying illustration of a boring-bar needs no explanation. A thorough test has shown that it is a good sub-



Boring-bar using Standard Square Stock

stitute for the flat-tool type of bar, and is cheaper, standard square stock being used, which avoids the fitting and grinding all over that is necessary with the flat tool. The same idea has also been carried out in single tool bars.

Jackson, Mich. M. E. Stock

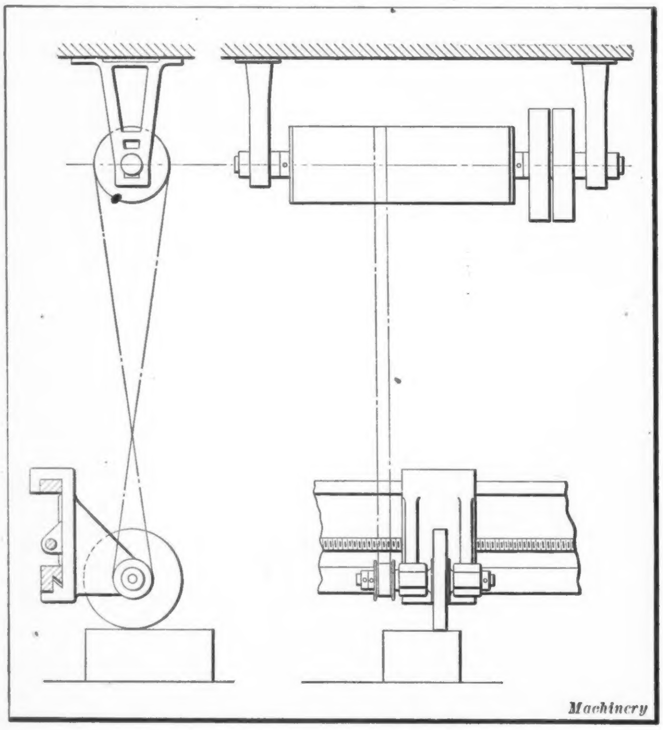
CHASING 100-PITCH THREAD WITH 50-PITCH CHASER

The chasing of a 100-pitch thread with a 50-pitch chaser described by Eric Lee in the May number of Machinery is similar to the work done by front and back V-tools. These are set first to cut diametrically opposite each other; then one is backed off, run along 2½ pitches, and run in to cut the third groove while the other cuts the first. But the chaser would do the better job of the two. Similarly, a 50-pitch chaser with six teeth can be made to cut a 150-pitch thread, with a lathe geared for 150 threads per inch.

New York City Robert Grimshaw

GRINDING CASTINGS WITH A PLANER GRINDING FIXTURE

A small New England shop received an order for some rectangular castings 15 by 7 by 5 inches. As the castings



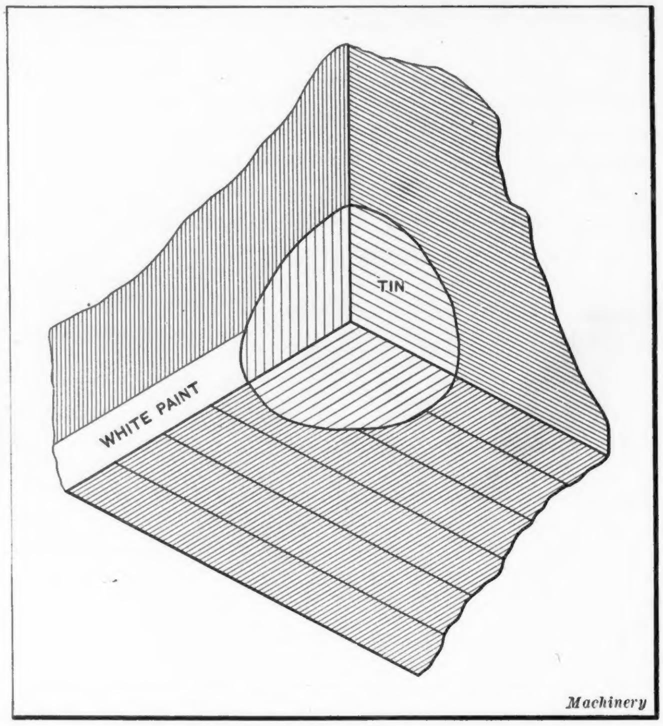
Planer Fixture for Surface Grinding Castings

reached the shop with rather rough surfaces, while the job called for smooth, though not finished, surfaces, it was decided to grind the castings to bring them to a more satisfactory condition. A 10-inch emery wheel, with a 1-inch face, was mounted on a bracket, as shown in the accompanying illustration, which was placed on the cross-rail of an old Gray planer, from which the tool-slide had been removed. The wheel was operated by a belt passing over a flanged pulley, on the bracket and a drum on the countershaft. The results obtained were satisfactory.

H. E. G.

CLEAN AND SAFE CORNERS

Dark corners attract, magnetically, dust and trash that seem to be unaffected by the neighborhood of light places. The moral of this is: pay more attention to the dark places, as they are likely to breed disease, general disorder and slouchiness, as well as to cause "spontaneous" fires. While it is seldom practicable to give these dirt pockets special illumination, it is perfectly feasible to paint them white, as well as to run a white strip along the wall, next the floor line, on the dark side of the room, as shown in the illustration.



Aids toward obtaining Clean and Safe Corners

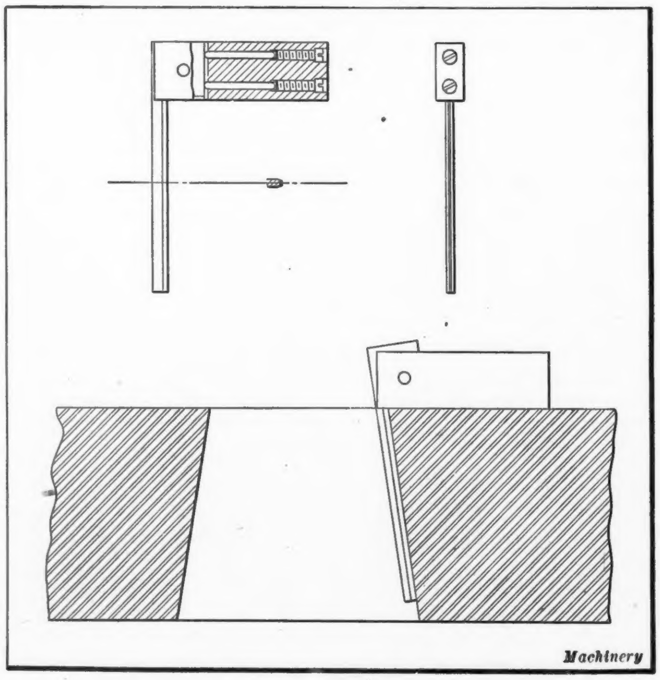
Further, if a trihedral piece of sheet tin, about 15 to 18 inches on a side, is fitted into such a corner, when sweeping, the dust and scraps can be collected with ease.

New York City Robert Grimshaw

SMALL-ANGLE PROTRACTOR FOR DIEMAKERS

The tool here illustrated was especially designed for use in backing the hole in a die away from its working edge. The blade may be moved over and set to any angle needed in this class of work—which rarely exceeds 5 degrees either way—by means of two screws in the end of the base. These screws engage with sliding pins that act on a projecting arm of the blade on opposite sides of the fulcrum pin, and thus firmly lock the blade in position. The narrow blade is beveled on its inside edge to almost a knife-edge, as shown in the sectional view. This form renders its use in gaging surfaces, especially concave surfaces, very convenient.

Ambridge, Pa. August J. Lejeune



Convenient Small-angle Protractor

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

TRIGONOMETRIC FUNCTIONS FOR ANY ANGLE

R. B.—I do not quite understand the latter part of your answer to the question concerning the trigonometric functions of any angle as printed in the August number of MACHINERY. You say that cos 685 degrees = cos 7 × 90 degrees + 55 degrees = cos 3 × 90 degrees + 55 degrees. How do you get 3 × 90 degrees + 55 degrees? It also seems to me that cos 3 × 90 degrees + 55 degrees should be — sin 55 degrees instead of + sin 55 degrees, as you have it.

A.—Near the bottom of the first column of page 1107, it is stated that if the angle is greater than 360 degrees (= 4 × 90 degrees), subtract 4 (or some multiple of 4) so that n will be less than 4, but not negative. In the present case, 685 degrees = 7 × 90 degrees + 55 degrees. Here $n = 7$; hence, subtracting 4 leaves 3 × 90 degrees + 55 degrees for the angle. The four quadrants subtracted do not affect the result, for after the revolving radius passes the 360-degree mark, the sequence of signs and values begins over again. The sign is plus, because the revolving radius stops in the fourth quadrant between D and A. The three quadrants (3 × 90 degrees) bring the radius to D, and the 55 degrees in addition carry it beyond D toward A. The angle may also be written 8 × 90 degrees — 35 degrees; in this case, subtract 2 × 4 quadrants, obtaining cos 8 × 90 degrees — 35 degrees = cos — 35 degrees = cos 35 degrees. The name of the function does not change, because the number of quadrants is even; and the sign is +, because the revolving radius stops in the fourth quadrant between A and D. In this latter case, the negative sign indicates that the revolving radius moves from A toward D instead of from A toward B. J. J.

MEASURING A 65-DEGREE V-THREAD

P. L. N.—I would like to have a formula for measuring a 65-degree thread of sharp V-thread form by the three-wire system.

A.—Referring to the accompanying illustration showing a 65-degree sharp V-thread, let:

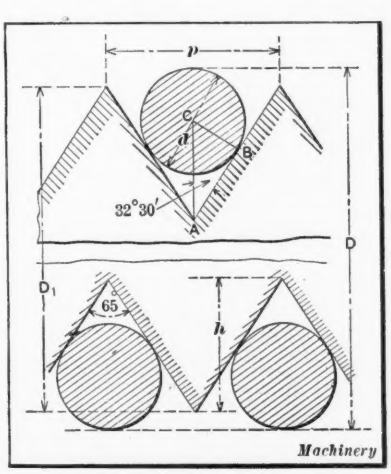
D = diameter measured over wires;

D_1 = theoretically correct diameter over the tops of the threads;

d = diameter of wire;

h = depth of thread;

p = pitch of thread.



Measuring 65-degree V-thread

The dimensions D_1 and p are known; diameter d is assumed; it may be made equal to about $0.6p$; h equals $\frac{1}{2}p$ × cot 32 degrees, 30 minutes.

By referring to the accompanying illustration, it will be seen that $D = D_1 - 2h + 2AC + d$.

But $AC = BC \div$ sin 32 degrees, 30 minutes $= \frac{1}{2}d \div$ sin 32 degrees, 30 minutes.

Hence, $2AC = d \div$ sin 32 degrees, 30 minutes.

Inserting this value in the formula above we have:

$D = D_1 - 2h + (d \div \text{sin 32 degrees, 30 minutes}) + d.$

MOVEMENT OF V-REST

L.E.S.—What should be the horizontal movement of a 90-degree V-rest to keep in contact with the work while the tool moves horizontally 1⅝ inch? The tool and the back-rest are to be moved by the same screw, but the threads are left and right, respectively. If the pitch of the one that moves the tool is ⅛ inch, what should it be for moving the rest?

Answered by F. Webster Brady, Scranton, Pa.

The illustration shows the lay-out of this problem. It will be seen that the rest must move horizontally a greater distance than the tool, that is, the horizontal distance AB is greater than the radial distance AC. The distance AB may be calculated as follows:

$AB = AC \div$ cos 45 degrees, or 1⅝ ÷ 0.707 = 2.298 or 2 19/64 inches.

If a pitch of ⅛ inch moves the tool, then the pitch for the rest must be greater in the following proportion:

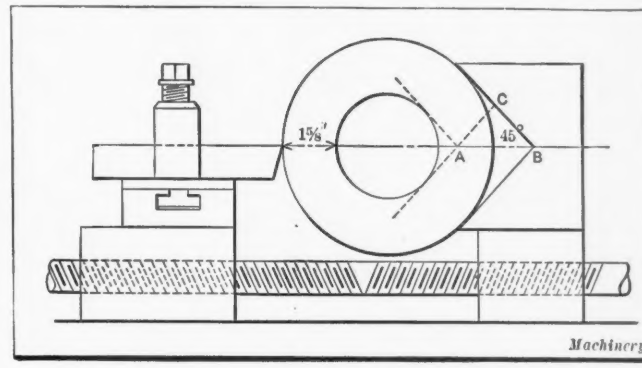


Diagram showing Relative Movement between Cutting Tool and V-rest

(2 19/64 ÷ 1⅝) × ⅛ = 0.177 or 11/64 inch.

A simple arithmetical solution of the problem, because of the angle of the jaws being 90 degrees, may be made as follows:

$2 \times AC^2 = AB^2$, and

$AB = \sqrt{2 \times 1⅝ \times 1⅝}$ = 2.3 or 2 19/64 inches (approximately).

If the jaw angle is not 90 degrees, then the general solution given above may be applied to all cases.

STRESSES IN WIRE ROPE DUE TO BENDING

H. A. J.—In a work relating to hoisting, I note the statement that the diameter of the sheave should be not less than 100 times the diameter of a rope having 6 strands, 7 wires to the strand, nor less than 60 times the diameter of a rope having 6 strands, 19 wires to the strand. How are the numbers 100 and 60 obtained, and why does the number of wires in a strand make such a difference in the diameter of the sheave?

A.—The actual value of these numbers is somewhat arbitrary, but their ratio should be about as you state, that is, 100:60. The following will make this clear. The strength of a wire rope is equal to the strength of one of the wires composing it multiplied by the number of wires in the rope. When a wire is bent around a cylinder, as shown in the illustration, the upper half is lengthened and the lower half is compressed, while the length of the center line is unaltered. Let R = radius of sheave, r = radius of wire, and D and d = corresponding diameters. The topmost element of the wire will then be lengthened by the bending an amount equal to $\pi(R + d) - \pi(R + r) = \pi r$, when the two parts of the rope are parallel, as shown in the illustration. The length of the wire that forms the semicircle is $\pi(R + r)$; hence, the unit elongation, or unit strain, is $s = \frac{\pi r}{\pi(R+r)} = \frac{r}{R+r} = \frac{r}{R} = \frac{d}{D}$, when the r in the denominator is dropped, as having no appreciable effect on the ratio. Let P = force required to bend wire, A = area of cross-section of wire, and S = unit stress;

then, $S = \frac{P}{A}$. The coefficient of elasticity E is defined as the ratio of the unit stress to the unit strain, or $E = \frac{S}{s}$ from which, $S = \frac{P}{A} = Es = E\frac{d}{D}$. This expression for the stress due to bending applies only to the topmost element of the wire; and as the various elements are located nearer the center, the stress in each becomes less. According to MACHINERY'S HANDBOOK, page 401, a prominent wire-rope manufacturer recommends the formula $S = \frac{Ed}{D} \times 0.45$, which is probably sufficiently close to actual conditions for practical purposes. Since the value of E is practically always the same for the same material, a change in S can be produced only by a change in the ratio $\frac{d}{D}$, and since this ratio is independent of the length of the arc of contact, it follows that the same bending stress will be produced when the rope is bent around a small arc as when it is bent around an entire circle. It is also evident that if D remains the same, the smaller d is the smaller will be the bending stress and, *vice versa*, the larger d is the greater the bending stress S.

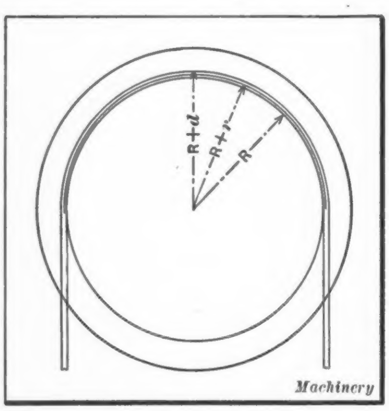


Diagram Illustrating Stresses in Wire Rope.

A 6 by 7 rope contains $6 \times 7 = 42$ wires, and a 6 by 19 rope contains $6 \times 19 = 114$ wires, therefore, for ropes of the same diameter, the wire in a 6 by 7 rope will be larger than in a 6 by 19 rope. Referring to pages 402-404 of MACHINERY'S HANDBOOK, $d = 0.106 \times d'$ for a 6 by 7 rope; and $d = 0.063 \times d'$ for a 6 by 19 rope, d being the diameter of the component wire and d' the diameter of the rope. The ratio of the right-hand members of these two equations is $\frac{0.106 \times d'}{0.063 \times d'} = \frac{0.106}{0.063} = \frac{1}{0.594} = \frac{100}{59.4}$, which is almost exactly the same as the ratio of 100:60. Some manufacturers permit the ratio $\frac{D}{d}$, to be as low as 80 for a 6 by 7 rope and as low as 48 for a 6 by 19 rope, but the values given in the question tend to greater safety. For a 1-inch 6 by 7 steel rope, $d = 0.106 \times 1 = 0.106$ inch, and the stress due to bending is $S = \frac{30{,}000{,}000 \times 0.106}{100} \times 0.45 = 14{,}310$ pounds per square inch, since for steel $E = 30{,}000{,}000$ and $D = 100 \times 1 = 100$. The area of the cross-section of the wires of a 1-inch rope is 0.3706 square inch; hence, the total stress P due to bending is $14{,}310 \times 0.3706 = 5303$ pounds $= 2.65$ tons. For a 1-inch 6 by 19 steel rope, $D = 60$ inches and $d = 0.063$ inch; hence, $S = \frac{30{,}000{,}000 \times 0.063}{60} \times 0.45 = 14{,}175$ pounds per square inch; the area is 0.3554; whence, $P = 14{,}175 \times 0.3554 = 5038$ pounds $= 2.52$ tons. These values are a little over one-third of the safe working load of extra-strong, crucible-steel, wire rope. J. J.

ANGLE OF REST OF SHELLS

L. J. F.—Please give me a formula for finding the angle x from the dimensions given in the accompanying illustration. This problem has to do with the angle of rest of shells, and a simple solution will be appreciated.

A.—This problem is difficult of solution, and there is no formula easily applied that will give the value of x to any degree of exactness. Evidently, angle $CQD = CAH = AOB = x$. $CE = 6 - (DQ - CF) = 6 - (56 - 56 \times \cos x) = 6 - 56\,(1 - \cos x)$. $CH = CE - (OB - GA) = 6 - 56(1 - \cos x) - 48\,(1 - \cos x) = 6 - 104\,(1 - \cos x)$. $HA = 60 - (QF + AB) = 60 - (56 \times \sin x + 48 \times \sin x) = 60 - 104 \times \sin x$. Also, $\tan CAH = \frac{CH}{HA} = \frac{6 - 104\,(1 - \cos x)}{60 - 104 \times \sin x} = \tan x$. This formula may be made general by substituting a for the dimension 6, b for 60, and R and r for the two radii, thus obtaining $\tan x = \frac{a - (R + r)\,(1 - \cos x)}{b - (R + r)\sin x}$. This equation can be solved only for particular cases, the best method of solution being the following: Write the equation in the form:

$$f(x) = \tan x - \frac{6 - 104(1 - \cos x)}{60 - 104 \times \sin x} = 0$$

Now assume values of x and substitute in the formula until the function becomes 0, or as near 0 as is desired. The work will be greatly facilitated by using the principles of interpolation. It is plain that $\tan x$ is a little greater than $\frac{DI}{BI} = \frac{6}{60} = 0.1 = \tan 5$ degrees, 40 minutes, nearly. Assume $x = 6$ degrees; then, using a four-place table and limiting all results to four decimal places, $f(x) = 0.1051 - \frac{6 - 104\,(1 - 0.9945)}{60 - 104 \times 0.1045} = 0.1051 - \frac{5.428}{49.132} = 0.1051 - 0.1105 = -0.0054$. Assume $x = 6$ degrees, 30 minutes; then $f(x) = 0.0033$. Since the function has changed sign, x lies between 6 degrees and 6 degrees, 30 minutes. Arranging the results in the form of a table and subtracting the upper function from the lower, the difference, neglecting the decimal points, is 87; subtracting the upper function from 0, the difference is 54; the interval is 30 minutes; hence, x is nearly equal to 6 degrees $+ \frac{54}{87} \times 30 = 6$ degrees, 18.6 minutes. If a more accurate value is desired, use a six-place table, and obtain results as shown in the margin. Here it is seen that x lies between 6 degrees, 18 minutes and 6 degrees, 19 minutes; the interval is 60 seconds. Subtracting the upper function from 0, the difference is 161; hence, $x = 6$ degrees, 18 minutes $+ 161 \div 294 \times 60 = 6$ degrees, 18 minutes, 33 seconds. This value of x substituted in the formula gives 0.000002 for $f(x)$.

x Deg.	Min.	$f(x)$	
6	00	-0.0054	
			87
6	30	0.0033	

x Deg.	Min.	$f(x)$	
6	18	-0.000161	
			294
6	19	0.000133	

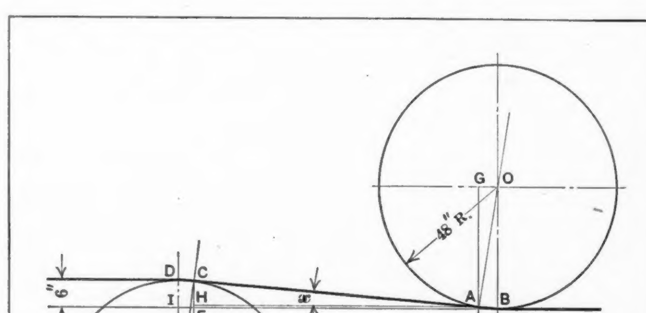


Diagram Illustrating Angle of Rest of Shells

The same problem, but with different dimensions, was sent in by B. V. D., one inquiry coming from Cleveland and the other from Buffalo, the dates of the letters being two days apart. The dimensions given by B. V. D. are $a = 0.050$, $b = 0.160$, $R = 0.125$, and $r = 0.045$. This problem can be solved in exactly the same manner; the work can be made a trifle easier by first multiplying all dimensions by 1000, thus obtaining $a = 50$, $b = 160$, $R = 125$, and $r = 45$. J. J.

STRENGTH OF CONDENSER TUBE PLATE

N. G. H.—Can you give me a method of calculating the unbalanced pressure which a condenser tube plate, such as that shown in Figs. 1 and 2, is capable of withstanding? In the present case, it is proposed to increase the pressure of the cooling water from slightly above atmospheric pressure to 15 pounds gage. The vacuum carried is 22 inches, the barometer being 26 inches (high altitude).

Answered by John S. Myers, Philadelphia, Pa.

Probably the most direct method of treating such problems is to calculate the thickness of a solid plate which would have the same strength as the perforated tube plate, so that the well-known formula for flat plates may be applied; then, since the pressure only acts upon the net area of the plate, *i. e.*, that between the tubes, increase the allowable pressure so calculated in the ratio of the gross area to the net area.

Fig. 3 shows the section of material between any two tubes. Referring to Fig. 3:

Area of portion a is $0.1 \times 0.875 = 0.0875$
Area of portion b is $0.35 \times 0.625 = 0.2187$

Total area of section is 0.3062

Taking the moment of section a about the center of section b and dividing this moment by the total area, we find the location of the center of gravity g of the section as follows:

$$x = \frac{0.0875 \times 0.75}{0.3062} = 0.214 \text{ inch}$$

The moment of inertia of the section is found by taking the sum of the areas a and b multiplied by the square of their distance from the center of gravity g, plus their moments of inertia about their own axis. Thus:

$$0.0875 \times 0.536^2 = 0.0252$$
$$0.2187 \times 0.214^2 = 0.0100$$
$$\frac{0.1 \times 0.875^3}{12} = 0.0056$$
$$\frac{0.35 \times 0.625^3}{12} = 0.0071$$
$$\text{Moment of inertia } I = 0.0479$$

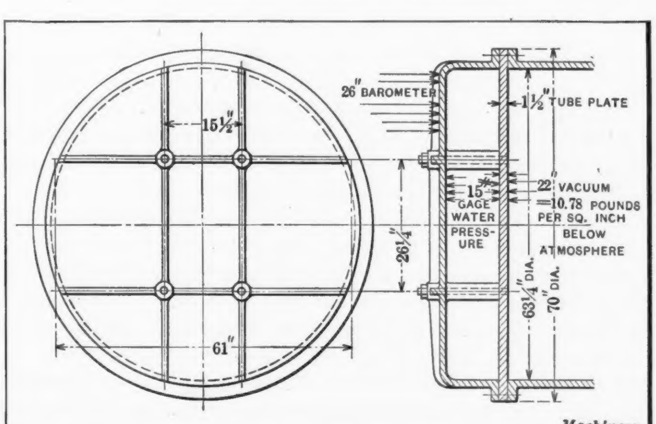


Fig. 1. Arrangement of Water Head and Tube Plate

$$\text{Section modulus for tension} = Z_t = \frac{I}{e_t} = \frac{0.0479}{0.526} = 0.091$$

The section modulus of a rectangle of breadth c and depth or thickness t is:

$$Z = \frac{ct^2}{6}; \text{ hence } t = \sqrt{\frac{6Z}{c}} \qquad (1)$$

Substituting in Formula (1) the value of Z just found and the center distance c between the tubes of 1.1 inch, we have:

$$t = \sqrt{\frac{6 \times 0.091}{1.1}} = 0.705 \text{ inch}$$

as the thickness of a solid plate equal in strength to the tube plate.

To obtain the net area of the plate over which the pressure acts, calculate the area of an equilateral triangle the length of the sides of which is c:

$$A_g = 0.433c^2 = 0.433 \times 1.1^2 = 0.524 \text{ square inch}$$

From this is to be subtracted the area of $3/6 = 1/2$ of a circle of diameter d. This area is $A_o = \frac{0.7854d^2}{2} = 0.393 \times 0.75^2 = 0.221$ square inch.

The net area between any three tubes, such as the shaded portion in Fig. 2, is then:

$$A_n = A_g = 0.433c^2 = 0.433 \times 1.1^2 = 0.524 \text{ square inch}$$

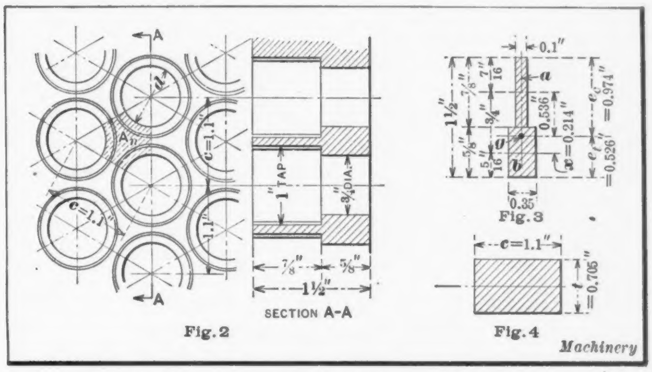


Fig. 2. Tube Spacing. Fig. 3. Section between Tubes. Fig. 4. Section of Equal Strength to that in Fig. 3

The ratio of gross area to net area is then:

$$\frac{A_g}{A_n} = \frac{0.524}{0.303} = 1.73$$

Most flat plate formulas are approximate only, and present the further difficulty that the case in hand is often dissimilar to that experimented upon, and for which the available formulas apply. Those formulas representing the cases studied by Grashof and Bach are probably the most reliable. For a rectangular plate such a formula accredited to Grashof is:

$$S = \phi \frac{B^2b^2}{B^2 + b^2} \times \frac{p}{t^2} \qquad (2)$$

from which

$$p = \frac{St^2}{\phi} \times \frac{B^2 + b^2}{B^2b^2} \qquad (3)$$

where S = stress in pounds per square inch;
p = pressure in pounds per square inch;
B = longest side of plate in inches;
b = shortest side of plate in inches;
ϕ = a coefficient determined by experiment.

When firmly secured at all four edges,
$\phi = 0.38$ for cast iron;
$\phi = 0.24$ for steel.

When supported at the edges but not restrained,
$\phi = 0.57$ for cast iron;
$\phi = 0.36$ for steel.

For our case we may consider a strip across the tube sheet of a breadth $b = 26.25$ inches, and average length, $B = 61$ inches, as indicated in Fig. 1. Now the ends of this strip, at the flange, are held firmly only at the sides; at the stays the plate is only partially restrained by the plate beyond it. For our purpose we may therefore take a mean value of $\phi = (0.38 + 0.57) \div 2 = 0.475$. With this value of ϕ and the value of $\frac{A_g}{A_n} = 1.73$, the coefficient for Formula (2) will become $\frac{0.475}{1.73} = 0.275$, and the similar coefficient for Formula (3) will be $\frac{1.73}{0.475} = 3.65$. For our case, we then have the approximate formulas:

$$S = 0.275 \frac{B^2b^2}{B^2 + b^2} \times \frac{p}{t^2} \qquad (4)$$

$$p = 3.65\,St^2 \times \frac{B^2 + b^2}{B^2 b^2} \qquad (5)$$

In Formula (4) the value of the unbalanced pressure in our case is $p = 15 + 10.78 = 25.78$, and $t = 0.705$. Substituting, we have for the stress in the tube plate:

$$S = 0.275 \times \frac{61^2 \times 26.25^2}{61^2 + 26.25^2} \times \frac{25.78}{0.705^2} = 8290 \text{ pounds per square inch.}$$

With cast iron having an average ultimate tensile strength of about 16,000, this would give an apparent factor of safety of $\frac{16,000}{8290} = 1.92$, which would be entirely too small a margin of safety, especially in view of the necessarily approximate methods of analysis which must be resorted to for such problems.

* * *

CODE OF SAFETY STANDARDS FOR POWER TRANSMISSION MACHINERY[1]

A tentative draft of a code of safety standards for power-transmission machinery states that the use of properly designed, constructed, and installed individual motor-driven equipment with electrical power distribution not only eliminates many of the hazards demanding this code, but also gives an uninterrupted distribution of natural and artificial light, and a greater flexibility and range of speeds than is possible with mechanical power-distributing systems.

The specifications describe standard guards for all power-transmission equipment later mentioned, and apply to all main shafting, jack-shafting, drive-shafting, and counter-shafting, and their belts and other attachments up to but not including belts actually driving machines. Belts actually driving machines are considered machine belts, and therefore a subject for machine codes.

Class A Guards—Class A guards are those used when the clearance between the guard and the guarded part is less than five inches. They consist of a metal guarding material that will not admit objects larger than one-half inch in diameter, and is strong enough to withstand loads to which it may be subjected, durable enough to withstand ordinary wear and tear, substantially fabricated and erected, and free from sharp points and edges.

Class B Guards—Class B guards are used when the clearance between the guard and the guarded part is five inches or more. They consist of a metal guarding material that will not admit objects larger than two inches in diameter, and is strong enough to withstand loads to which it may be subjected, durable enough to withstand ordinary wear and tear, substantially fabricated and erected, and free from sharp points and edges.

Hand-rails—If the clearance between the guard and the guarded part is fifteen inches or more (measured horizontally from extreme parts within six feet of floor), a hand-rail forty-two inches in height with at least one intermediate rail, supported at least every eight feet, substantially fabricated and erected, and with no sharp points or edges may be used. If constructed of pipe, the rails and posts shall be at least equal in strength to 1¼-inch standard-weight pipe. If constructed of structural metal, the rails and post shall be at least equal in strength to 2- by 2- by ¼-inch angles. If constructed of wood, the top rail shall be 2 by 4 inches, the center rail 1 inch by 4 inches, and the posts 4 by 4 inches, all straight-grained lumber dressed on four sides, or other construction of equal strength.

Toe-boards—When power-transmission equipment extends through floors or into pits, the standard guards shall extend to the floors, or toe-boards six inches in height shall be provided around the floor opening in addition to the standard hand-rails.

Sanitary Bases—The standard guards, for power-transmission equipment not extending through floors, shall enclose exposed sides to two inches below the bottom of the lowest moving part when the clearance between that part and the floor is less than eight inches. When the clearance is eight inches or more, the guards shall be closed on the bottom, or extended on all sides down to six inches above the floor.

Gears and Sprockets—All power-driven gears and sprockets shall be completely enclosed on exposed sides with standard guards, except where the design and operation of the parts to be guarded make a complete enclosure clearly impracticable. In this case the face of the gears or sprockets shall be covered with a band guard surrounding all exposed teeth, with flanges on both sides extending inward beyond the roots of the teeth, and there shall be a continuous smooth web cast or fitted between the hubs and rims of the gears or sprockets.

Vertical and Inclined Belts, Ropes, and Chains—All vertical and inclined belts, ropes, and chains used for transmitting or distributing power (except belts traveling less than 120 feet a minute, or transmitting so little power that accidental contact can cause no accident) shall be provided with standard guards six feet high on exposed sides, or on exposed sides and top, or with a standard hand-rail on exposed sides.

Horizontal Belts, Ropes, and Chains—All horizontal belts, ropes, and chains used for transmitting or distributing power (except belts traveling less than 120 feet a minute, or transmitting so little power that accidental contact can cause no accident) shall be guarded as follows: If the upper part of the belt is less than six feet above the floor or working platform, it shall be provided with standard guards six feet high on exposed sides or on exposed sides and top, or with a standard hand-rail on exposed sides. If the upper part of the belt is more than six feet above the floor or working platform and the lower part of the belt is less, it shall be provided with standard guards, six feet high on exposed sides, or with a standard hand-rail. If the lower part of the belt is more than six feet above the floor or working platform and lower than seven feet, it shall be provided with standard guards on exposed sides and bottom, or with a standard hand-rail. Where a horizontal belt is located over a driveway or passageway, the highest floor of any wagon or truck passing beneath the belt shall be considered a working platform.

Belt Fasteners—All belts not provided with standard guards and within seven feet of the floor or working platform shall be free from metal lacings and metal fasteners.

Belt Shifters—Belt shifters shall be provided for all tight- and loose-pulley belts. These shall be so designed and constructed that ordinary vibrations or accidental contact will not alter the set position; they shall also have a controlling handle conveniently located.

Pulleys—Pulleys belted from above or from the side in such a way as to allow passage beneath them, and within seven feet of the floor or working platform and not completely enclosed by standard belt guards or hand-rails, shall be guarded to the top of the pulley or to a height of seven feet above the floor or working platform on exposed sides and beneath by standard guards or shall be enclosed on exposed sides by standard hand-rails. Pulleys without belts shall be guarded as though belted, or removed from revolving shafts.

Bearing Clearance—The clearance on shafting between pulleys and bearings or between pulleys and fixed objects shall be not less than thirty-six inches or the width of the belt, or the pulleys shall be guarded on the near side with standard stationary guards, and all revolving objects in the clearance shall be smooth, cylindrical, and concentric with shafting.

Belt Clearance—The clearance on shafting between pulleys and pulleys, collars, couplings, or other revolving attachments shall be wider than the widest belt used, or the pulleys shall have flanges or guards to prevent the belt from dropping into the clearance.

Clutches—Friction, jaw, and compression clutches within seven feet of the floor or working platform or within thirty-six inches of a bearing shall have their operating mechanism completely enclosed in standard stationary guards, or in smooth, concentric, revolving guards of solid construction with no projecting parts or attachments.

Couplings—All couplings within seven feet of the floor or working platform or within thirty-six inches of a bearing shall be guarded as follows: Sleeve and flange couplings shall

[1] Submitted by the sub-committee on the Protection of Industrial Workers to the American Society of Mechanical Engineers, in Cincinnati, Ohio, May, 1917.

be cylindrical and concentric with the shafting and with no parts or attachments projecting beyond the largest periphery of the coupling or its projecting flanges. Flexible and universal couplings shall be completely enclosed in standard stationary guards, or in smooth concentric revolving guards of solid construction. Clamp couplings and makeshift devices of irregular shape or unknown strength are prohibited on power-driven shafting.

Collars—Assembled collars shall be smooth, cylindrical, and concentric with shafting, with no projecting parts or attachments.

Set-screws—All set-screws in revolving parts not enclosed by standard guards shall be flush with or countersunk below the periphery of the part retaining the set-screws.

Keys—All keys or keyways in revolving shafting not enclosed by standard guards shall be made flush with the end and periphery of the shaft or enclosed by smooth, cylindrical, concentric guards.

Vertical Shafting—Vertical shafting with or without collars, couplings, clutches, pulleys, or other attachments shall be enclosed on exposed sides with standard guards to a height of six feet above the floor or working platform, or with a standard hand-rail.

Horizontal Shafting—Horizontal shafting with or without collars, couplings, clutches, pulleys, or other attachments, including dead ends, within seven feet of the floor or working platform, shall be enclosed on all exposed sides with standard guards, a standard hand-rail, or freely revolving tubing. Where horizontal shafting is located over driveways or passageways, the highest floor of a wagon or truck passing beneath the shafting shall be considered a working platform.

Emergency Stop Stations—A station, or stations, shall be provided in each room, section, or department to stop immediately all power-transmission equipment therein. Such station, or stations, shall be properly marked, easily accessible, and provided with means for locking in the "stop" position.

Bearings—Where possible, bearings shall be of a self-oiling type with reservoir capacities for at least twenty-four hours' running or they shall have methods of oiling that do not bring the oiler into the danger zone. They shall also have necessary drip-cups and pans securely fastened in position.

Lubrication—Oiling that brings the oiler into a danger zone shall be done only by an authorized person and while the machinery is not in motion. The oiler must not wear loose or flowing clothing, and shall be provided with a lock and key or with a key to the locks at the emergency stop stations. He shall also have a warning sign. He shall be required to lock a station in a "stop" position and display the sign before going to work, and shall unlock and remove the sign when the work is completed and all men have left dangerous places.

Starting Signals—Ample notice should be given, by means of an effective alarm or signal, in all departments before power-transmission equipment is started.

Inspection—All power-transmission equipment should be carefully inspected at frequent and regular intervals by foremen or authorized inspectors, and defective equipment should be reported for repair and records kept of inspections.

Repairs and Adjustments—Repairs and adjustments to power-transmission equipment or guards shall be made only when the power is shut off from that equipment, and guards shall be replaced in protective position before the power is turned on.

Removing Guards—Guards installed in accordance with this code shall not be removed or rendered ineffective.

* * *

DISPOSAL OF METAL CHIP WASTE

BY MARK MEREDITH [1]

Metal chips, in the shape of borings, turnings, and planing scrap, often amount to 10 per cent of the total production of machine shops; and it is not an easy matter to dispose of this waste material to advantage. The most economical way is to use it in place of other materials in furnace mixing, but it is difficult to charge a furnace with loose chips. The forced draft blows away a large proportion, and a large part of that which remains is subjected to violent combustion and goes at once into the slag as ferric oxide. When loose chips are charged into a furnace, it is safe to say that at least half the total weight is wasted, and the large amount of viscid slag produced interferes with the efficient working of the furnace.

Some years ago it was suggested that the metal chips might be packed in wooden or metal cases before they were added to the furnace mixture, but taking everything into consideration, this method is far from economical. Another method that was advocated was to expose the chips to the atmosphere, so that they might rust into a solid form, but this was found to be expensive. The proposal to feed the chips into the furnace with a low-power blast also has been found unsatisfactory. Some engineers have added binding material to the chips and pressed the mixture into bricks, but in almost every case the binder disintegrated the moment it was exposed to heat and the briquets simply broke into free metal dust. There was then a great loss due to oxidation, under the action of the binder, besides the ordinary furnace loss.

For many years German engineers have been trying to develop a method of using low-grade ore and waste metal in their country. As a result, that nation has become the largest user of waste steel plate, and solved the problem of utilizing metal chips to the best advantage some time ago with almost complete success. In all German metal-working shops, the chips are saved and sheltered, as far as possible, from atmospheric influence. If the shop has not the necessary facilities for dealing with the chips, they are stored until a sufficient quantity has accumulated to justify sending them to a works that can handle them efficiently. The method adopted is to load the metal scrap into a press and subject it to a very high pressure, thus compressing it into briquet form without the aid of any binding material. These blocks are then charged into the furnaces and practically no loss results through burning or through particles being blown away, so that this waste may be used instead of expensive grades of pig iron in the production of high-grade cast metal. In steel foundries it has been pointed out that these briquets might be substituted for the low-phosphorus white iron that is now in such demand. In fact, they can be economically used in any place where steel scrap is used, whether it is in the foundry or the steel mill, as briquets of steel or wrought iron are a good charging material. Chips from hard rolls, projectiles, and the like may be mixed with gray-iron chips, so as to make a uniform charging material.

Chips from copper, brass, bronze, and white metal have also been pressed into briquets, with a considerable saving in cost. This is due to the fact that the cost of pressing the chips is much less than the savings that are effected in other ways, such as in the oxidation of the metal in remelting, the easier methods employed in handling the chips, and economy in space required for storing.

* * *

The iron ore mined in the United States in 1916 reached a total of 75,167,672 gross tons, the greatest annual output ever made. There were shipped from the mines 77,870,553 gross tons, valued at $181,902,277. The quantity mined was over 19,600,000 tons more than in 1915; the quantity and value of the ore shipped were increased 40 and 80 per cent, respectively. The average value per ton at the mines was $2.34 as against $1.83 in 1915. These figures do not include iron ore containing 5 per cent or more of manganese.

The production of pig iron, including ferro-alloys, was 39,434,797 gross tons in 1916, compared with 29,916,213 gross tons in 1915, an increase of 32 per cent. The pig iron, exclusive of ferro-alloys, sold or used in 1916, amounted to 39,126,324 gross tons, valued at $663,478,118, compared with 30,384,486 gross tons valued at $401,409,604 in 1915, a gain of 29 per cent in quantity and 65 per cent in value. The average price per ton at furnaces in 1916 was $16.96, compared with $13.21 in 1915, an increase of 28 per cent. The increase from January to December, 1916, in the prices of standard grades of pig iron at the large iron centers ranged between 45 and 68 per cent, but this increase was confined almost entirely to the last two or three months of the year and does not affect the average greatly.

[1] Address: 67 Dale St., Liverpool, England.

METAL PLANERS AND METHODS OF PRODUCTION[1]

The problem of providing the increased speeds and power to develop the possibilities of high-speed steel and to meet the increasing necessity for greater production has been a comparatively simple one in machines in which the cutting is continuous and the motion of the tool is in one direction only. It has meant merely adding power and strengthening parts. The speeding-up process introduces, however, a vastly different problem in machines in which the cutting is not continuous and which have a return motion of the tool. The principal limitations of machines of this class, especially the planer, are the inertia of the moving mass at the moment of reverse and the speed at which the tool enters the work. The problem of overcoming these limitations has had the attention of quite a number of engineers, yet, while considerable progress has been made, the complete solution does not seem to have been reached.

The evolution of the planing machine has followed along the lines of increased table speeds. The earlier demands were for a higher return speed, in the belief that great savings could be effected by reducing the idle time consumed in the return of the table. Then it was found that further gains could be made by increasing the cutting speed, owing to the fact that this part of the cycle consumes the greater part of the time involved; the advent of high-speed steel can be credited largely with the marked advance in this part of the development. Next there came the demand for variable cutting speeds; for to operate a planer having only one cutting speed was both wasteful and detrimental to the best methods of increased production.

This constant change of conditions and the desire to obtain the highest possible speeds in both directions led to serious difficulties for which a change in design became imperative. One of the objections to the speeding-up of the planer was the difficulty encountered at the reverse, namely, the inertia of the moving parts. Tests established the fact that the greater part of the trouble was caused by heavy machine pulleys and their high speeds, so various types of clutch drives were designed in which the pulleys were not reversed; but these developed the objectionable features inherent in friction clutches. The use of an aluminum alloy for the pulleys instead of cast iron, however, not only overcame most of the objections to the heavier pulleys, but made higher speeds possible and thus increased the number of cutting strokes, as less time was consumed in the reverse. These pulleys also effected quite a saving in power.

Electric Planer Drives

The subject of individual electric motor drive for planers has received considerable attention in the past few years. One type that has been successfully developed is the 2 to 1 variable-speed motor, coupled direct to the top driving shaft of the planer. Its speed is controlled by two separate sets of resistance, which are automatically operated by a master switch connected to the shifting mechanism of the planer. The cutting speed can be varied from 25 to 60 feet per minute, while the return speed can be varied without affecting the cut. The controller handles are set to a predetermined speed before starting and the planer is operated in the usual manner from the tumbler, the master switch automatically varying the speed of the motor at each reversal.

Probably the most interesting motor application to planers is the reversible motor drive. While the application of this type of drive is not new, the drive approaches more nearly the ideal planer drive than any method heretofore used. The motor is an adjustable-speed motor, having a speed range of 1 to 4, so that a large range of cutting speeds from 25 to 60 feet per minute can be obtained. A double set of resistance makes it possible to vary either the cutting or the return speed independently of the other. This arrangement has also simplified the problem of variable speeds in connection with this drive.

[1]Abstract of a paper by Charles Meier read before the American Society of Mechanical Engineers at Cincinnati, Ohio, May, 1917.

The operating mechanism is handled in exactly the same manner as is the standard belt-shifting type planer. Two predominating features are the total absence of belt slippage under heavy cutting and the lower peak loads at the moment of reverse. The superiority of this drive is shown in that in one test the travel of the cutting stroke was increased from 24 feet per minute, by either a single or double belt drive, to 35.8 feet by this drive; and the travel of the return stroke was increased from 66.6 feet to 85.7 feet per minute.

Value of Jigs and Fixtures in Planer Work

As a general rule, comparatively little thought is given to the subject of handling work on the planer. If the same amount of time and study were devoted to providing jigs and fixtures for the planer that is given other machining operations, the saving in time would be astounding. With planers, as with any other machines, we depend on the operator to a large extent for the best results. The question of chucking the work is left to his discretion, and he proceeds to the best of his ability with the equipment allotted him, which usually consists of an assortment of bolts, clamps and blocks, instead of jigs and fixtures. In innumerable cases the chucking time alone almost trebles the cutting or machining time. Add to this the time lost in changing tools and measuring work, and it is found that on an average the total actual time required to complete a piece of work is from four to five times the theoretical time necessary to plane the piece, the theoretical time being based on the number of square inches to be planed and the cutting and return speed used. In the greater number of cases, a holding fixture with screw adjustments can be devised so that it is only a matter of dropping the piece into this fixture and applying the clamps, which should be part of the fixture. Hardened steel plugs can also be incorporated in the jig to indicate the various heights and angles of the piece without using scales or referring to a drawing. Gang tools and double-end cutters also assist greatly, as they save considerable time in getting correct sizes without measuring.

For instance, when short-wall coal-cutting machine main frames were planed by clamping and stopping them on the planer table, the average time required for each frame was twenty-eight hours. Since the proper jigs and fixtures have been provided, these frames are now being planed complete in four hours. On this jig, bosses are planed on which hardened blocks are placed for setting the tools. Another good result obtained by time studies has been the planing of locomotive cylinders complete in one setting. As a general rule, these cylinders are planed one at a time and several settings are required. After a careful study, fixtures have been devised by which the four surfaces can be planed at one time, using four tools for the cutting instead of only one. The saving in time on a pair of these cylinders is about 100 per cent.

* * *

American manufacturers of gasoline farm tractors will produce about 50,000 tractors this year to meet a demand for about 100,000. Last year they built about 39,000 tractors, and it was hoped to produce about 70,000 this year, but the shortage of labor and materials and lack of standardization has cut the figure to a possible 50,000. It is estimated that there is a field for a million of these tractors in this country. Great Britain has found it necessary to standardize farm tractor construction, and America faces the same problem. The Society of Automotive Engineers, which embraces in its membership the engineers representing such industries as automobiles, motor tractors, farm tractors, aeroplanes, motorcycles, motor boats and stationary gas engines, has started the work of tractor standardization. The society was responsible for the standardization work accomplished in connection with American automobiles, and its engineers are now standardizing aviation motors and planes.

* * *

The United States consul at Hong Kong says that China's increased demand, at the close of the war, for machinery like pumps, rice mills, gas engines, etc., will be much smaller than is generally anticipated, because of the growing tendency to manufacture such machinery in the Far East.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

ROBSON & SORENSEN TWO-PART BALL BEARING

In the construction of many types of machinery, need has been felt for a split ball bearing which could be applied on lineshafts and other equipment without the necessity of taking down the shafting, and on automobile crankshafts, etc., where the form of the machine member would make it otherwise impossible to apply a ball bearing. It is a generally accepted axiom in the manufacture and operation of ball bearings that as soon as a bearing raceway or the balls carried by that raceway begin to show wear, the life of the bearing will soon come to an end. Bearing this fact in mind, inventors who have turned their attention to the development of a split ball bearing have endeavored to overcome the inevitable joint between the two halves of the races by machining the joints to such a degree of perfection that the balls could run over the joints without appreciable shock and therefore with no consequent damage.

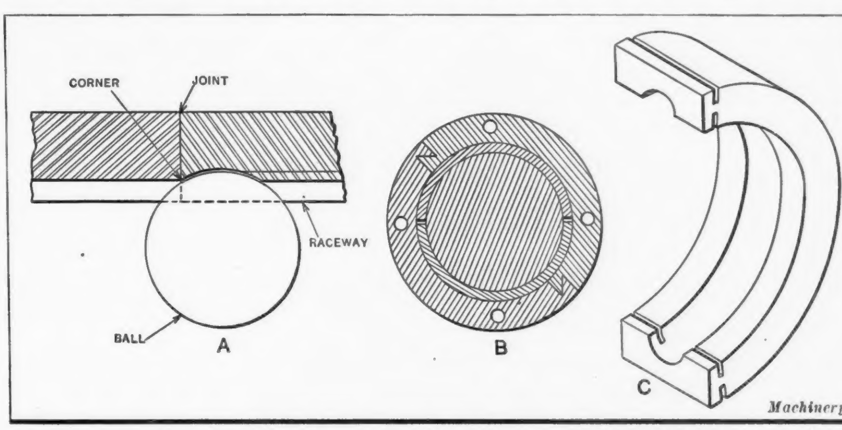


Fig. 1. A, Diagram showing Effect of Distortion on Two-part Ball Bearing Races with Close Joints; B, Two-part Lock Nut Construction; C, Outer Raceway of Robson & Sorensen Two-part Ball Bearing

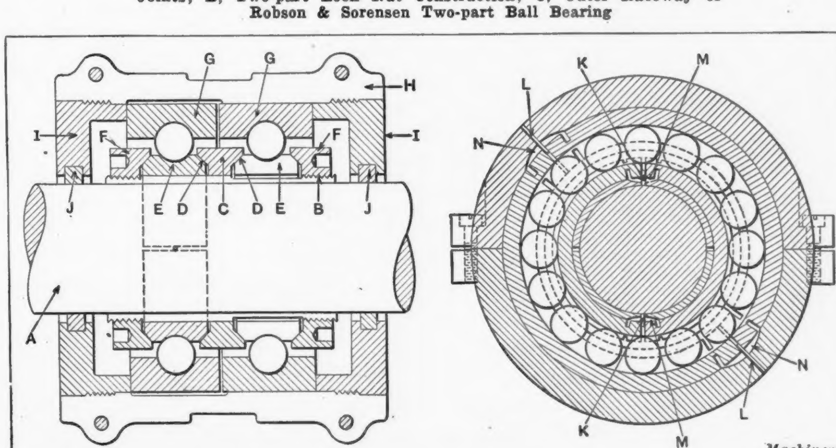


Fig. 2. Longitudinal and Cross-sectional Views of Robson & Sorensen Two-part Ball Bearing

Those who worked on this principle overlooked the important fact that steel is an elastic material and is subject to considerable distortion when placed under the stress introduced by heavily loaded balls running in the raceways. Where the attempt is made to produce a satisfactory two-part ball bearing by the use of highly finished joints between the raceway segments, satisfactory results will not be obtained for the reason which is shown diagrammatically at *A* in Fig. 1. Here it will be seen that as the loaded ball approaches the joint, distortion of the steel depresses half of the raceway below the other, with the result that each ball strikes a sharp corner or step as it passes over the joint. This will soon cause wear in the balls and raceways, and when such wear has started it means that complete destruction of the ball bearing will take place in a comparatively short length of time.

Upon this principle of the elasticity of steel, Robson & Sorensen, 430 Bridge St., Spring City, Pa., have developed the two-part bearing, best understood by referring to the illustration of half of an outer raceway for this bearing shown at *C* in Fig. 1, and the longitudinal and cross-sectional views of the bearing shown in Fig. 2. In a well-designed bearing the balls are all made of exactly the same size—this accuracy being held within 0.0001 inch—in order that the load may be uniformly distributed over the balls. It is apparent that a heavily loaded ball running over a joint in a divided ball bearing raceway would result in considerable damage being done to both the raceway and balls; if, on the other hand, the load could be relieved from the balls as they pass over the joints in the raceways, practically no damage would result. Realizing the importance of this point, it was decided to provide means for relieving each ball in the bearing of its load as the ball passes over one of the joints in the raceway. This result is accomplished by cutting transverse slots across the outside and inside of the raceways at points adjacent to the joint, this idea being shown at *C* in Fig. 1 and in Fig. 2.

As a ball reaches the section of the raceway immediately adjacent to the joint, this part of the raceway is deflected by the pressure of the ball, which results in the ball dropping below the circle formed by adjacent balls running on the solid sections of the raceway, and as a result, the ball is practically relieved of load—just enough load remaining to keep the end of the raceway slightly deflected. As a result, the ball runs over the joint with practically no load upon it, and so the tendency toward wear of the balls and raceway is eliminated. The criticism may be offered that this slotting of the raceways would have a tendency to cause them to break, but this point has been given careful consideration and the cross-section of the metal at the bottom of the slots is ample to prevent trouble from this cause. It will, of course, be realized that the deflection of the end of the raceway segments is only 0.001 or 0.002 inch.

The type of shaft mounting shown in Fig. 2 is the original design, which is rather complicated and expensive. Now it is the practice to mount the inner raceway directly on the shaft by means of two two-part clamps fitted into annular grooves on each side of the ball groove. It will be possible, however, to gain a clear idea of the bearing construction by referring to Fig. 2, where the shaft to be supported by the bearing is shown at *A*, and on this is mounted a two-part sleeve *B*, which carries a flanged collar *C* loosely mounted upon it. This collar has a beveled under-cut portion *D* at each side, against which bear the segmental inner bearing races *E*, which are beveled at each side to conform to the contour of the collar at *D*. At the outside, these inner races are secured by two-part nuts *F*, which are suitably beveled to engage the races and threaded on the inside to enable them to be screwed onto either end of sleeve *B*. Nuts *F* and collar *C* are

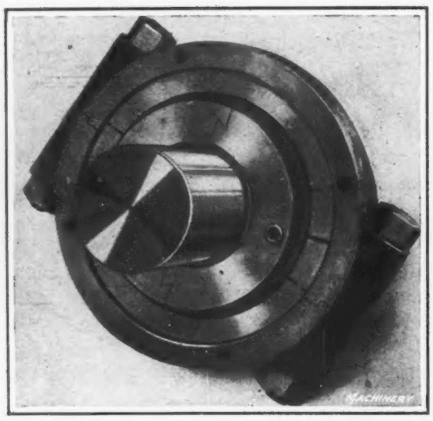


Fig. 3. Close View of Assembled Bearing with End Plate removed

of split construction, as shown at *B* in Fig. 1. Consequently, when assembled in this way, the two-part nut is practically a single piece, and as this nut is screwed onto sleeve *B* (Fig. 2), it draws the sleeve firmly onto the shaft while the bevel on the outside of the nut draws the bearing race down onto the sleeve.

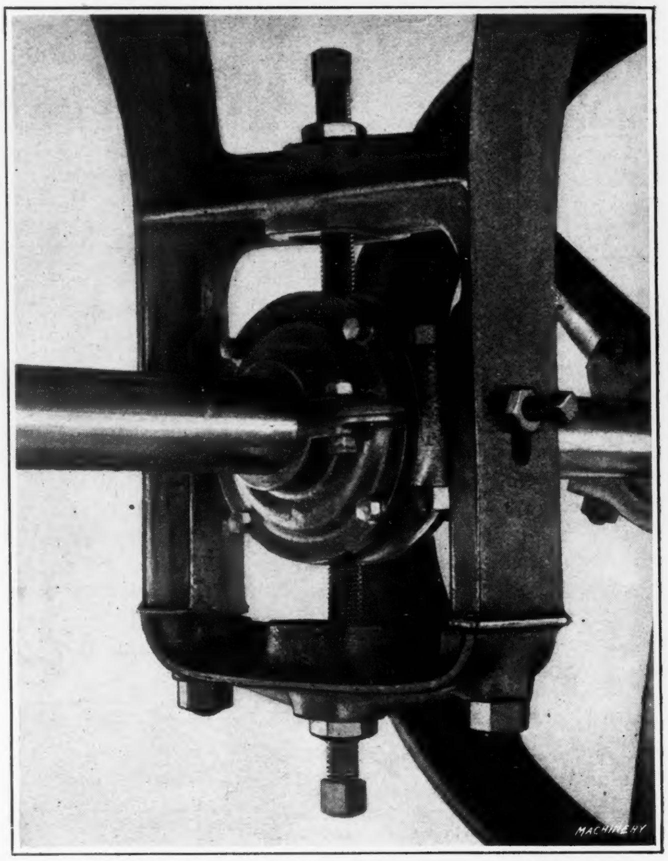


Fig. 5. Robson & Sorensen Two-part Ball Bearing mounted in S K F Hanger

In assembling one of these bearings it has been found desirable to have the inner races *E* arranged so that the divisions of one bearing raceway are out of line with the divisions of the other raceway or raceways which comprise the bearing. In Fig. 2 is shown a bearing with two sets of balls and raceways, but bearings of this type may be arranged with a greater number of raceways if so desired. Also, it will be apparent from Figs. 3, 4 and 5 that the design of these bearings does not depend for successful performance on having two or more bearings assembled directly opposite each other, as illustrated in Fig. 2. Tests have shown that this is non-essential. In Fig. 2 the outer bearing raceways are shown at *G*, and it will be seen that these raceways fit into a casing *H*, which is also made in two sections that are secured in the present instance by transverse bolts or by some other suitable design. Heads *I* are screwed into the threaded ends of casing *H*, and the ends of these heads bear against the outer bearing raceways *G* and hold them in proper alignment with the inner raceways. It will be apparent that these heads have openings considerably larger than the diameter of the shaft, and annular grooves are provided to receive packing rings *J*.

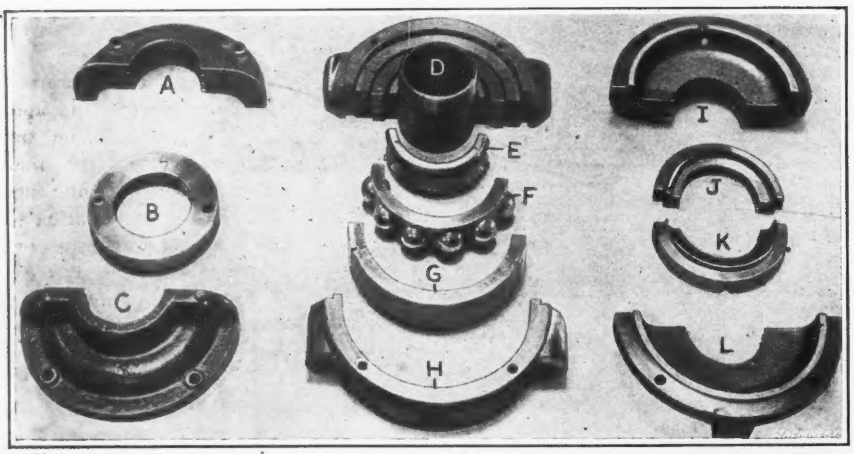


Fig. 4. A-C, Upper and Lower Halves R. H. End Plate; B, R. H. Lock Nut; D, Upper Half Complete Bearing with Upper Cap and Shaft Adapter; E-G, Lower Half Inner and Outer Raceway; F, Lower Half Ball Cage; H, Lower Cap; I-L, Upper and Lower Halves L. H. End Plate; J-K, Upper and Lower Halves L. H. Nut Lock

In order to prevent the inner bearing raceways *E* from turning on sleeve *B*, flat pins *K* are provided, which project up from sleeve *B* and extend into the spaces between the ends of the bearing raceways *E*. Similarly, it is necessary to prevent the outer bearing raceways *G* from rotating independently of casing *H*, and this result is accomplished by flat pins *L*, which extend from the joints in casing *H* into the spaces between the ends of the outer raceways. It will also be noticed that in order to allow the ends of the inner and outer raceways to be deflected by the ball pressure in the manner to which reference has already been mentioned, clearances are provided at *M* and *N*. The exterior of the casing can be formed in any suitable manner to accommodate the type of hanger to be used. In Fig. 5 one of the Robson & Sorensen bearings is shown mounted in an S K F lineshaft hanger. From the preceding description it will be apparent that this type of ball bearing construction makes it possible to apply a ball bearing at any point on the lineshaft or any continuous shaft without the necessity of taking down the shaft to enable the bearing to be slipped over the end. Similarly, the two-part ball bearing can be mounted on crankshafts or other machine members which are of such a form that it would be impossible to support them in one-piece ball bearings of standard design.

BREWSTER "ETCHOGRAPH"

In all shops where small tools, milling cutters, saws, etc., are used, the occasion frequently arises for applying various marks. This may be for the purpose of branding the tools with the name of the shop in order to

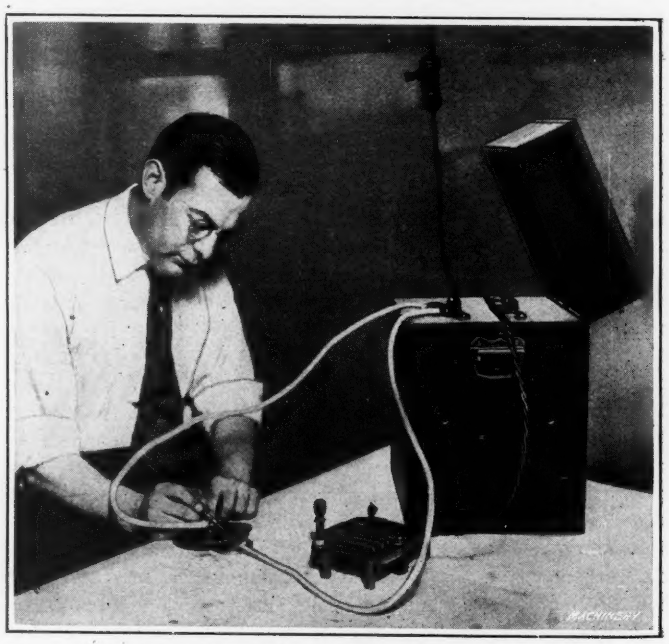


Fig. 1. Brewster "Etchograph" engaged in marking Tools

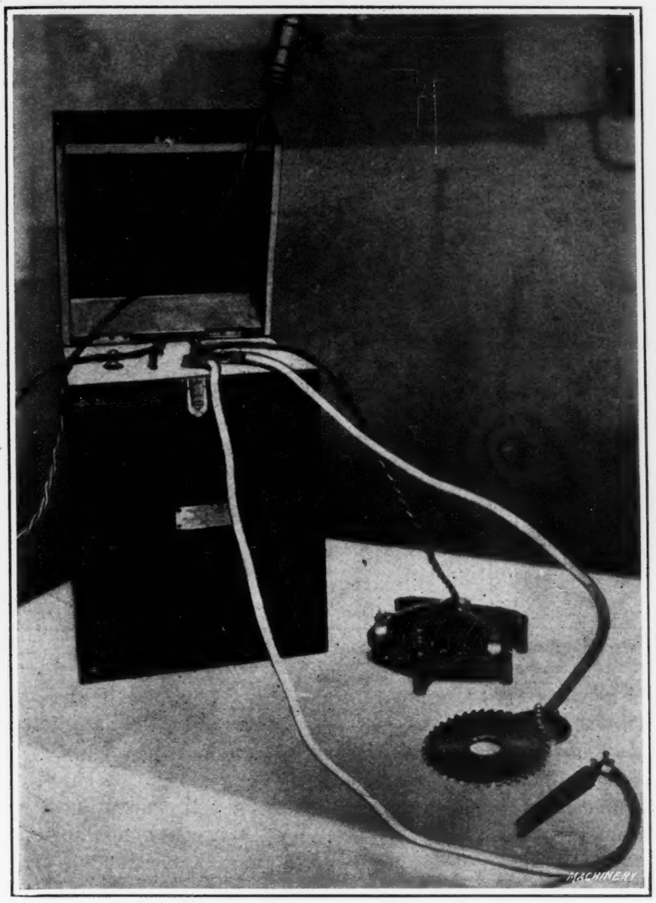


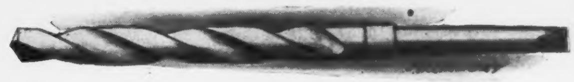
Fig. 2. Electric Marking Machine known as the "Etchograph," made by William Brewster & Co., Inc.

avoid theft; it may be found necessary to designate the size of a tool or the operation for which it is employed, and numerous other occasions may arise which make it necessary for a tool to be marked. To meet the requirements of this work, William Brewster & Co., Inc., 30 Church St., New York City, has developed an electric marking machine which is known as the "etchograph." It consists of a transformer for connection with an ordinary electric lighting circuit to provide for obtaining the required current and voltage for operating the etchograph. Two leads are taken off from the secondary of the transformer, one of which runs to a steel plate of considerable size upon which the work to be marked is placed. The transformer used is made by the Adams-Bagnall Co., Cleveland, Ohio.

The other lead runs to what is known as the "pencil" of the etchograph. This pencil has a hardened rubber handle and a clamp at the end to which is secured the lead from the transformer. This clamp also carries a small copper point, made from an ordinary piece of wire, with which the marking is performed. As this point is drawn over the surface of the work, the higher electrical resistance of the iron or steel to be marked results in producing a burn on the surface of the work, leaving a dark oxide mark on the metal. This machine is adapted for use in connection with standard alternating current of 110 volts, 60 cycles, and the consumption of current from the line is from 1½ to 2 amperes. When alternating current is not available, a D.C.-A.C. converter can be furnished at low cost. This current is stepped up so that when delivered from the secondary of the transformer, there are 20 amperes of current at a potential of 2 volts available for marking. To provide for obtaining the desired depth of marking, a rheostat is furnished which provides for adjusting the amount of current delivered to the pencil of the etchograph. This pencil is used as an ordinary lead pencil would be handled, and provision may be made for either writing free hand script or for printing, according to the class of marking which may be desired. The etchograph is adapted for marking either iron or steel, and all classes of high-speed carbon and machine steel may be marked with equal facility, no matter whether it is in the hardened or soft condition.

RUSS FORGED DRILLS

There has been a question as to whether it was possible to forge a twist drill from a solid steel blank and make the operation a commercial success, both as regards the cost of production and quality of workmanship. It is claimed that the practicability of securing satisfactory results in this way has been proven by the A. E. Russ Forged Drill Co., Cleveland, Ohio, and this firm is now manufacturing and supplying the trade with its "Drill Far" forged twist drills, one of which is shown in the accompanying halftone illustration. In carrying out this manufacturing operation, a round bar of high-speed steel is forged down to the desired diameter, after

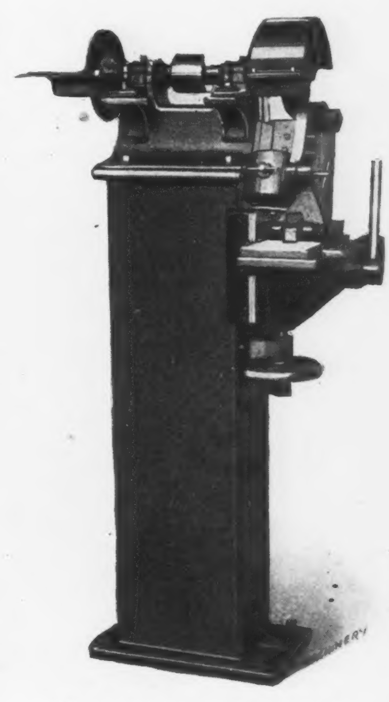


A. E. Russ Forged Twist Drill

which it is subjected to a second forging operation to form the flutes. It is claimed that these two forging operations tend to give the steel a more compact structure and that the forging operation compels the fibers of the steel to follow the spiral instead of running straight from end to end. Greater strength should be obtained in this way, because the different fibers in the metal would afford each other mutual support when the drill was placed under strain, and so there would be less tendency toward breakage. This would make it practicable to use high speeds and heavy feeds.

SLEEPER & HARTLEY NAIL DIE GRINDING MACHINE

To meet the requirements of firms operating automatic nail making machinery for a grinder for use in sharpening the dies used on such machines, a die grinder of this type was brought out by Sleeper & Hartley, Inc., 68 Prescott St., Worcester, Mass. The machine was primarily designed for use in connection with Sleeper & Hartley nail machinery, but is now offered to nail makers using other types of equipment. It will be seen that the machine is provided with two wheels mounted upon a double-ended spindle, one of these wheels being used for squaring the dies, while the other has a V-shaped formed edge for grinding the pointing dies. Below this wheel there is a table mounted on the machine frame for vertical travel and made adjustable to and from the wheel with a screw actuated by a handwheel. This table carries a support adapted to receive the holder in which the die is mounted for grinding. This support is adjustable in a lateral direction in order to bring the die into line with the wheel, while the die-holder itself may be rotated in the support to locate the die in any one of three grinding positions. When positioned, the die is reciprocated to and fro past the wheel, while the whole table may be fed to or from the wheel as desired. Equipment of the machine includes one die-holder made according to the customer's specifications, and a countershaft for driving the machine. This machine occupies a floor space of 16 by 22 inches in size and has a net weight of 350 pounds.



Nail Die Grinding Machine built by Sleeper & Hartley, Inc.

WESTINGHOUSE INDUCTION MOTOR CONTROL PANELS

Where it is desired to combine in one unit the complete control equipment for wound-rotor induction motors, a neat, safe and convenient means either for starting or for speed variation is provided by Type RF control panels, manufactured by the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. By their use, motors are provided with complete protection from injury due to overloads, failure of voltage and improper starting. Panels are suited to all applications where drum controllers may be employed. Each outfit consists of a pipe-mounting slate panel, on which is mounted an oil circuit-breaker for the primary circuit, a drum controller for the secondary circuit, and, when desired, one or more meters mounted on the panel. Resistors are separately mounted. One of the most interesting features of these panels is an interlock between the oil circuit-breaker and the drum controller, which renders it impossible for the operator to start the motor without all the resistance in the secondary. These panels are recommended for service in which reversing is seldom or never required.

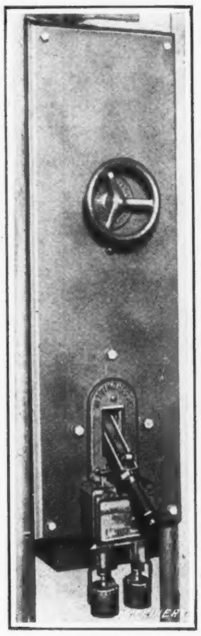


Fig. 1. Westinghouse Control Panel

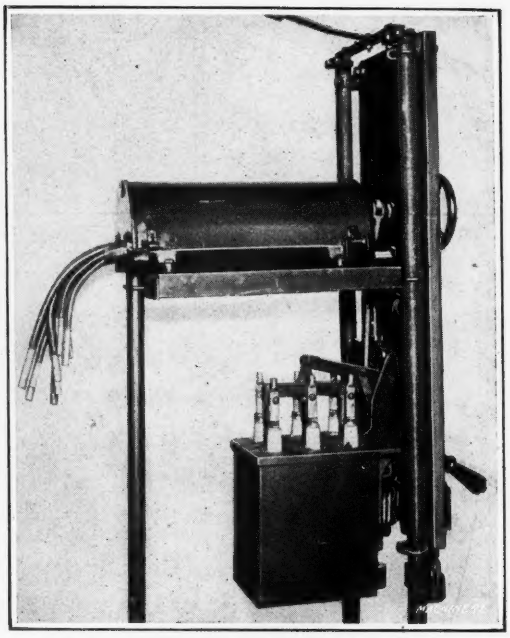


Fig. 2. Opposite Side of Westinghouse Induction Motor Control Panel

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TRIUMPH RADIAL DRILL

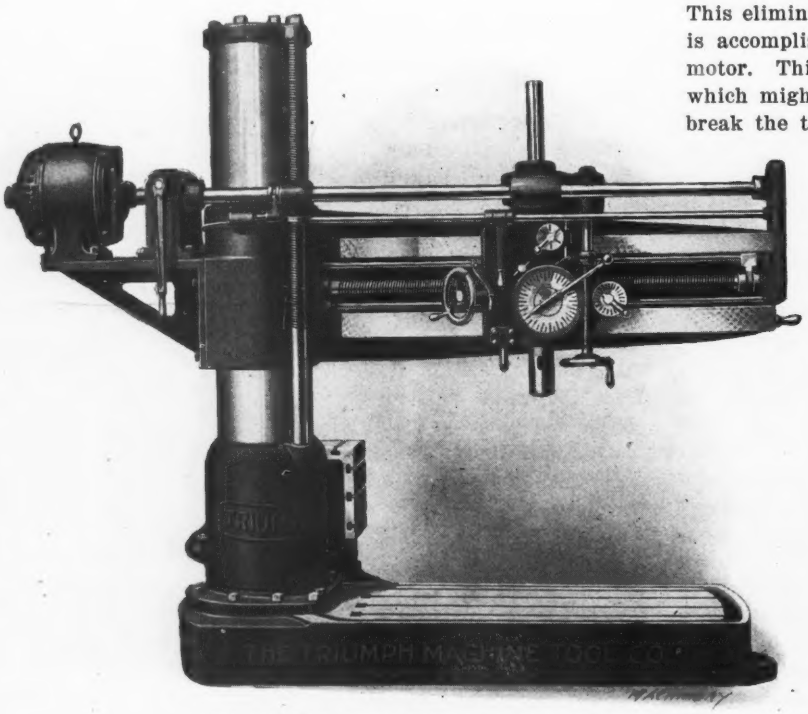
The Triumph Machine Tool Co., 1276 E. 55th St., Cleveland, Ohio, is now building the 6-foot radial drilling machine which is illustrated and described herewith. It will be apparent that the machine is furnished with individual electric motor drive, making it possible to place this radial drill in any position in the shop to suit existing conditions, regardless of the position of lineshafts, etc. Space under traveling cranes or in out of the way corners may be utilized in this way. On this machine all controls are placed in the spindle head, making it possible to lock and unlock or raise and lower the arm, lock the sleeve to the column, change the speed of the spindle, run in the forward or reverse direction, or stop the spindle, move the head along the arm by power, and change the rate of feed to the spindle without requiring the operator to change his position. By mounting the variable-speed motor on the arm, the number of driven parts required is lessened.

The arm of this radial drill is made of a heavy section and is adequately ribbed at both the top and bottom. It is provided with liberal sized gibs and its bearing upon the column is of ample length. The spindle head is supported by three gibs on the arm and may be moved to any position by means of a power-driven rapid traverse screw mounted in the arm. This screw may be engaged, disengaged or locked as required. A handwheel provides for making minor adjustments. The spindle is made of high-carbon crucible steel and is supported in phosphor-bronze bearings, the thrust being taken by a ball bearing. Drive is accomplished by a worm and wheel, the worm having a 30-degree pressure angle, and although ample power is provided, the drive is perfectly noiseless. This is the only driving mechanism located in the head.

Automatic return of the spindle is accomplished in such a way that when the drill has reached a predetermined depth the feed is knocked out and the spindle automatically returned to the upper position. The gear-box is located at the rear of the machine in front of the motor and contains gears furnishing three ratios—one speed for heavy tapping, etc.—and is provided with an accelerated speed to provide for the use of small drills. Under normal conditions of operation there are no gears in mesh, as the motor drives direct through the shaft which carries the worm, thus eliminating all noise and providing an efficient transmission of power to the spindle head. The gears are of steel and submerged in an oil bath.

Reversal of the direction of rotation is accomplished by reversing the motor, the start, stop and reverse lever being located on the spindle head within easy reach of the operator. This eliminates all shock when tapping, as the braking effect is accomplished electrically by reversing the current in the motor. This eliminates the necessity for reversing clutches, which might give trouble through slippage or a tendency to break the tap or drill. Feeds are instantly available at the spindle head by the use of an indicator, and available rates of feed are 0.006, 0.009, 0.015 and 0.024 inch per spindle revolution. This range meets the requirements of all ordinary conditions, and changes of feed are obtained by merely setting the indicator.

The column is made in two sections, the inner portion or mast being attached to the base, while the sleeve is mounted upon this column and provided at the top and bottom with roller bearings to make the movement of the arm easy and to take the thrust load. The outer sleeve extends almost to the base of the machine and is provided with means of clamping to the inner column. The motor control is located on the spindle head and gives twenty-one speeds in either direction, without the operator being required to change his position. With the geared transmission, the number of available speeds in either direction is increased to sixty-three; and constant speed is maintained at any given speed.

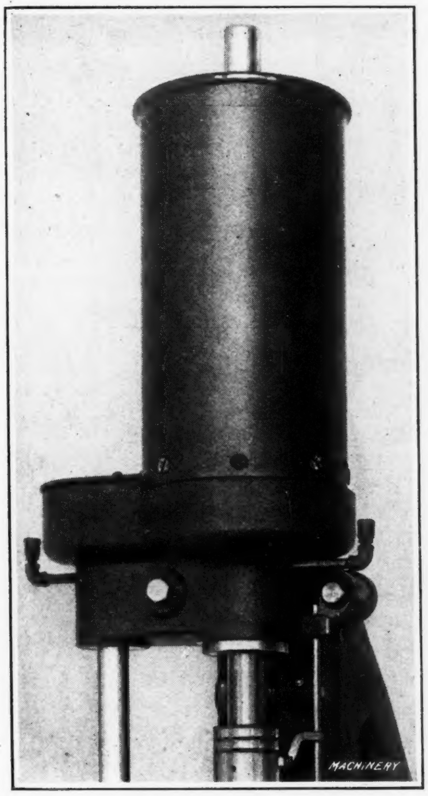


Radial Drill built by the Triumph Machine Tool Co.

Principal dimensions of this machine are as follows: height of base, 9 inches; working surface of base, 4 feet by 6 feet, 8 inches; vertical movement range of arm, 4 feet; horizontal movement range of head, 4 feet, 2 inches; minimum and maximum distance from base to spindle, 8½ inches and 6 feet, 2 inches; minimum distance from base to center of head, 39 inches; minimum distance between column and spindle, 24 inches; capacity in plane of base is to drill to center of circle of 6-foot radius; range of motor drive speeds for 5-horsepower motor, 775 to 3100 revolutions per minute; range of spindle speeds, 15 to 260 revolutions per minute; least diameter of spindle at driving section, 2 9/16 inches; vertical traverse, 19 1/2 inches; and net weight of machine complete with motor, approximately 16,500 pounds.

COLBURN TAPPING HOOD

To provide for relieving the strain on the side of the keyway in spindles of its drilling machines while the machines are engaged in the performance of heavy boring and tapping operations on work of large diameter, the Colburn Machine Tool Co., Franklin, Pa., is making a tapping hood in various sizes to fit different types of Colburn heavy-duty drilling machines. Power from the driving gear is transmitted through a cross bar, which is keyed and held rigidly to the spindle by means of a clamping screw. The outer extremities are slotted to form a slidable fit with square keys seated into the inside surface of the drum. This drum is attached directly to the spindle driving gear, so that there is no sliding contact in the keyway of the spindle, such a contact taking place on the double keys inside the drum. This tapping hood is machined inside and out and is claimed to be in perfect balance. It can be used when the machine is run up to the highest speeds without the least danger of introducing vibration.



Tapping Hood for Colburn Drilling Machines

DETROIT BELT LACER

In lacing a belt it is essential to obtain strength and durability, and to do the work by a method which enables it to be handled rapidly in case of emergency. These features are obtained through the use of machine-closed wire belt lacing which gives the added feature of smoothness of operation under all conditions. The Detroit Belt Lacer Co., Hubbard Ave. and A St., Detroit, Mich., is now making the "Bulldog" belt lacing and a machine for lacing up belts in this way. It is claimed that "Bulldog" lacing applied with this machine gives a perfect staggered grip on the belt and shows a minimum reduction of cross-sectional area on any cross-section for a given size of wire. "Bulldog" belt lacers are put up 84 hooks to the section, which is full 12 inches long, and 12 sections are packed in a box which contains slightly in excess of 144 inches of lacing with six full-length sections of rawhide pins. These lacers are made in four sizes known as Nos. 3, 4, 5, and 6 for lacing thin, medium, heavy and extra heavy belts, respectively. Rawhide pins are sold in 12-inch lengths and are also made in four sizes, 3/32, 7/64, ⅛ and 9/64 inch in diameter for use in connection with respective sizes of lacers to which reference has just been made.

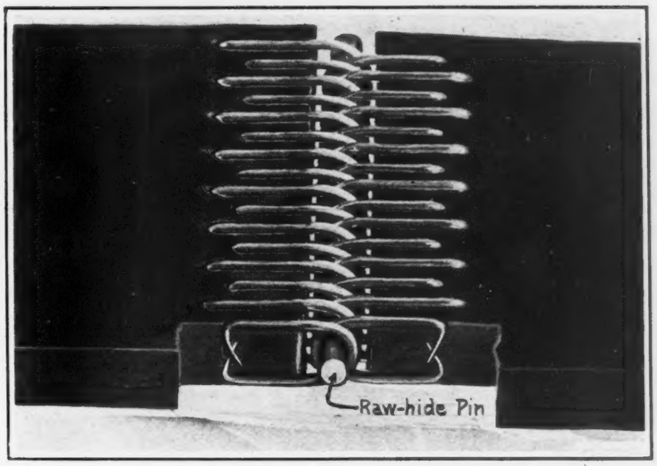


Fig. 1. Belt laced with "Bulldog" Belt Lacing made by Detroit Belt Lacer Co.

The "Bulldog" closing machine shown in Fig. 3 is furnished with two handles, either of which operates the machine leaving the other hand free to hold the belt. Consequently, one man can operate the machine without difficulty. The belt hooks are driven in from both sides and are always central. Fig. 2 shows a removable holder for lacers. The required sections of lacers is put into the holder and the holder is slipped into the closing machine, after which the lacers are driven home by pushing down the hand lever. This holder can also be used for closing lacers in a vise or with a hammer. Features of this belt lacer, to which particular attention is called, are as follows: The detachable holder enables the lacers to be properly arranged before the holder is inserted in the machine. The double handles on the machine enable the operator to pull either handle which is most convenient for him; either handle operates the machine and the operator always has one hand free to hold the belt. The removable holder centers the hooks properly and they are driven in from both sides, the positioning being such that there is a minimum reduction of cross section. Any thickness of belt may be laced in this way and secure a joint which runs over the pulleys almost as smoothly as other sections of the belt.

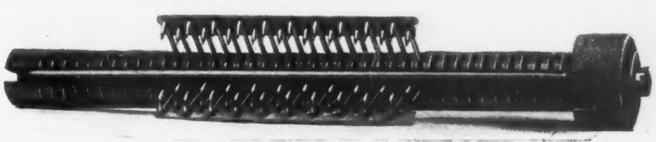


Fig. 2. Removable Holder for "Bulldog" Lacers Ready to be put into Closing Machine

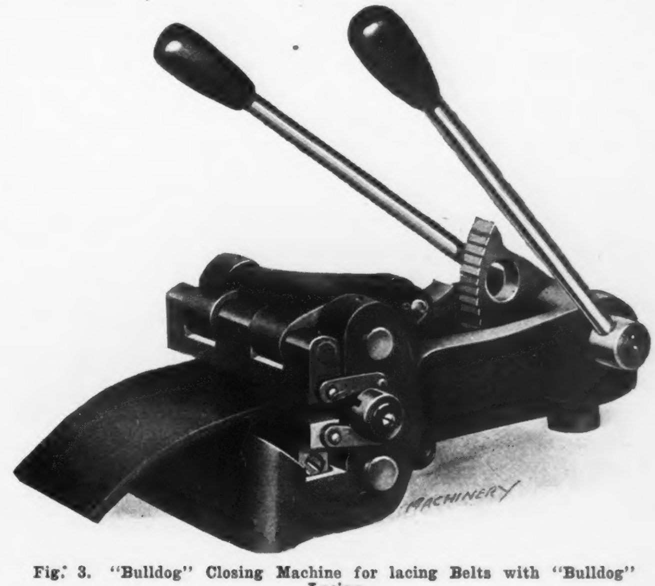


Fig. 3. "Bulldog" Closing Machine for lacing Belts with "Bulldog" Lacing

"RESISTAL" SAFETY GOGGLES

In Fig. 1 are shown what are known as "Resistal" goggles which are well adapted to the requirements of machinists and other workmen engaged in shops where there is danger of having their eyes injured by flying particles of metal,

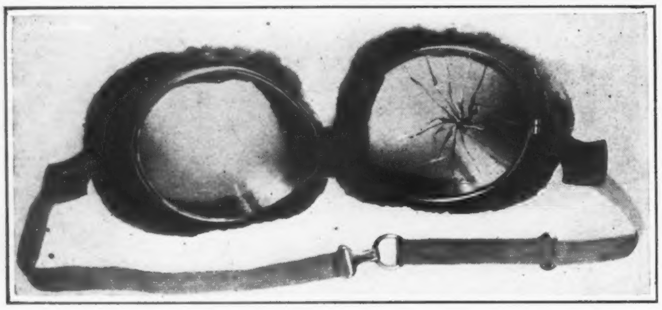


Fig. 1. "Resistal" Goggles made by Strauss & Buegeleisen

abrasive, etc. The name "Resistal" was adopted because although the crystals can be cracked they cannot actually be broken with a hammer blow. In cracking, there is no flying of splinters to jeopardize the eyesight of the wearer. The crystals are made of two layers of optical glass which may be either flat or curved, and between the two layers of glass there is introduced a layer of celluloid, the whole being cemented into a solid mass. This produces a crystal which has every virtue of glass but none of its drawbacks. The strength and safety features of celluloid goggles is obtained, but the crystals are unscratchable, rigid, and perfectly fireproof; they are not affected by water, heat or cold, and the celluloid layer is said to provide a heat insulating medium which prevents clouding up the glass due to condensation of moisture. Goggles with "Resistal" crystals are made with either clear amber or "euphos" colors and are sold by Strauss & Buegeleisen, 37 Warren St., New York City. Crystals may also be obtained in special forms for use in industrial masks used by welders, sandblast operators, etchers, etc.

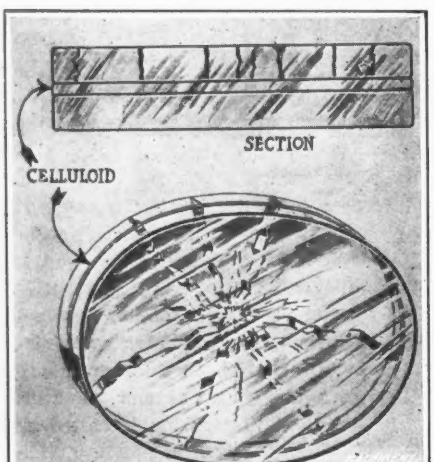


Fig. 2. Broken Crystal, showing Construction

SILVER UPRIGHT DRILLING MACHINE

One of the latest additions to the line of drilling machines built by the Silver Mfg. Co., Salem, Ohio, is a 25-inch upright machine which is illustrated and described herewith. This drilling machine was especially designed to meet the requirements of severe service, but is capable of producing work of high accuracy. Eight spindle speeds are obtainable, four of which are secured with open belt drive and four by transmission through the back-gears, which are fully enclosed and may be quickly engaged by means of a conveniently located lever. Six positive geared feeds are obtained, and any feed may be instantly engaged while the machine is running. The spindle is made of high-carbon crucible steel and provided with an imported ball thrust bearing. Both spindle and sleeve are accurately ground, and the spindle and sliding head are sensitively counterbalanced by means of a weight inside the column. This weight is attached by means of a chain to a notched lever and the sensitiveness of the spindle counterbalance may then be adjusted to suit conditions by simply varying the position of the chain connection on the lever. The sliding head has a wide bearing on the column to which it is rigidly secured and is easily adjusted up and down owing to its perfect balance.

Two quick-return levers are used; the one situated on the right-hand side can be slid back and forth in its bearing, and when withdrawn to its full length it is suitable for hand drilling in light work. The automatic stop for the down feed is set by graduations on the spindle and may be instantly disengaged either by hand or power. This enables holes to be drilled to any desired depth. The swinging table is of

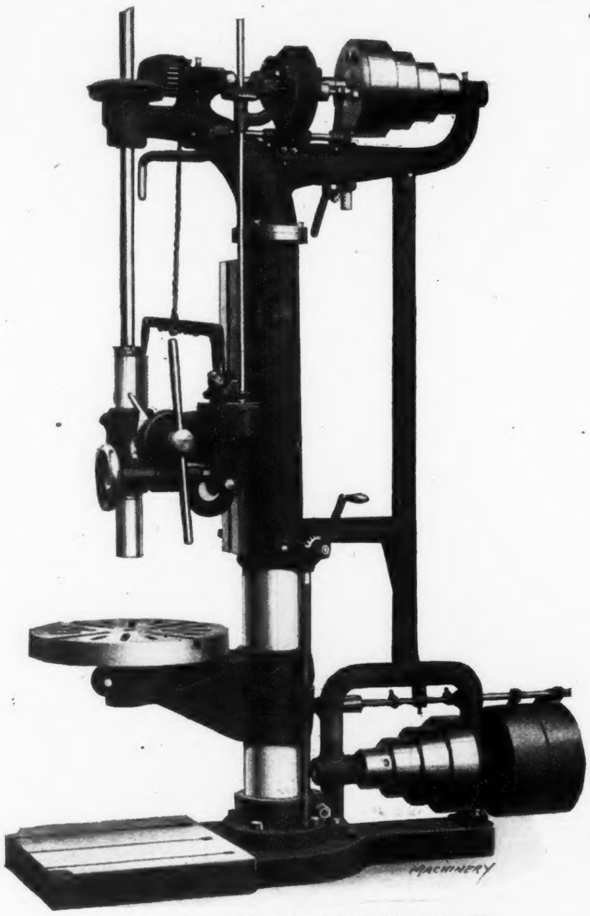


Fig. 1. Silver 25-inch Upright Drilling Machine

rigid construction and is in perfect alignment with the spindle and column. The supporting arm is provided with a wide bearing on the column, and it may be easily raised or lowered by means of a screw. It will be apparent that the frame is symmetrical in design and liberally proportioned to provide the necessary strength and rigidity for heavy work. A tapping attachment provided for use on this machine consists essentially of four bevel gears, one intermediate pinion and two positive clutches, the intermediate pinion being mounted on an eccentric so that it may be thrown out of mesh when the attachment is not in use.

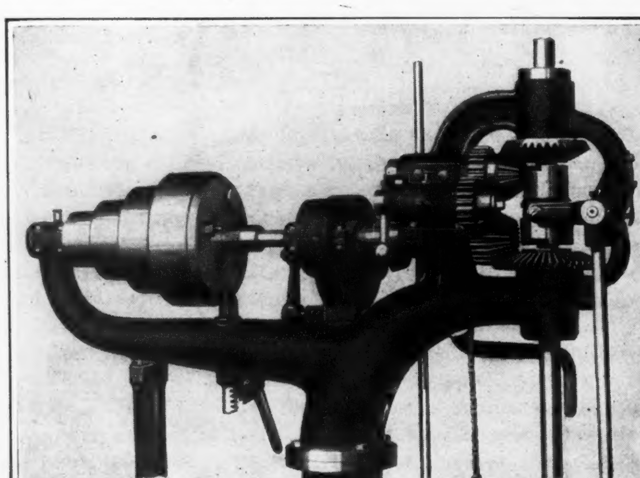


Fig. 2. Close View of Arrangement of Gearing for Tapping Attachment

The principal dimensions of this machine are as follows: height, 7 feet, 3 7/16 inches; maximum distance spindle to base, 48 inches; maximum distance spindle to table, 31 inches; distance from column to center of spindle, 12⅞ inches; traverse of table on column, 16 inches; traverse of head on column, 22¼ inches; diameter of table, 21¼ inches; diameter of column, 6⅝ inches; diameter of spindle, 1⅝inch; diameter of sleeve, 2⅞ inches; Morse taper hole in spindle, No. 4; maximum feed of spindle, 9¼ inches; ratio of bevel gears, 2 2/11 to 1; ratio of back-gears, 3¾ to 1; size of driving pulleys, 4¼ by 12 inches; diameters of largest and smallest steps on cone, 10 and 4 inches, respectively; face width of cone pulley steps, 3⅛ inches; speed of countershaft, 275 R.P.M.; range of spindle speeds, 14 to 315 R.P.M.; range of feeds, 0.0056, 0.009, 0.012, 0.014, 0.021, and 0.031 inch per revolution; floor space occupied, 22 by 62½ inches; and net weight of machine, 1650 pounds.

SEBASTIAN GEARED-HEAD LATHE

The Sebastian Lathe Co., Cincinnati, Ohio, is now building a geared-head, quick-change lathe in 13-, 14- and 15-inch sizes. These three lathes are all of the same general design. Eight mechanical speed changes are provided in the headstock, ranging from 19½ to 487 revolutions per minute. Two levers control these speed changes, four changes being obtained by the left-hand lever, while this number is doubled by the right-hand lever, which provides for engaging either the direct or back-geared drive. The spindle is made of 40- to 60-point carbon steel, and is carried in bronze-bushed bearings. All shafts are made of steel, and careful provision has been made for lubrication of all bearings.

The entire headstock is packed with grease, which affords constant lubrication to all gears and moving parts. Lathes of this type may be furnished with or without individual motor drive, the top of the headstock being planed to receive a motor where individual electric drive is required, and power is transmitted by either a belt and idler pulley to maintain the desired tension or by a chain and sprocket wheels. The switch for motor control is arranged either at the front of the motor or on the back of the bed, and in the latter case control is obtained from the apron. Any make of motor for direct or alternating current—either constant or variable speed—may be used.

The quick-change gear-box occupies the space ordinarily taken up by the intermediate gear and quadrant. All shifting gears are made of steel, and twenty-four changes of feed are obtained. Eight rates of feed are secured by operating the sliding tumbler, which is locked in position by a pull pin, and these are compounded by placing the knob in any of its three positions. Bronze bushings are provided for all running bearings in the feed-box. A plain change-gear can be furnished, if desired, instead of the quick-change gear-box. This box cuts from five to thirty-six threads per inch, including the 11½ pipe thread. The tailstock has an adjustable side movement to provide for the performance of taper turning operations and is so designed that the compound rest can be swung at right angles.

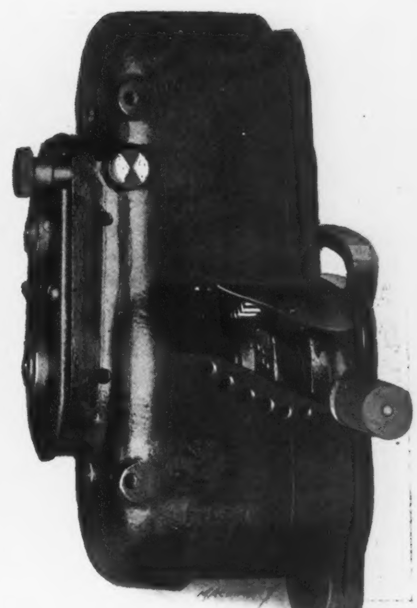


Fig. 2. Quick-change Gear-box

The carriage has long bearings on the ways and is provided with ample means for lubrication; it is gibbed to the bed at both the front and back and provided with T-slots. Both a lead-screw and feed-screw are provided, and the carriage is furnished with power cross-feed. Regular equipment of the lathe includes a compound rest, steady- and follow-rests, large and small faceplates, a plain rest, and a friction countershaft if the lathe is not arranged for motor drive. These lathes are built with a gap bed, the gap being 7¾ inches long and 3½ inches deep, thus increasing the swing of the lathe in the gap by 7 inches. The bed is braced at the gap in such a way that there is no weakness at this point. A bridge block, which may be easily placed in position or removed, may be fitted in the gap, but this bridge cannot be fitted after the lathe is finished.

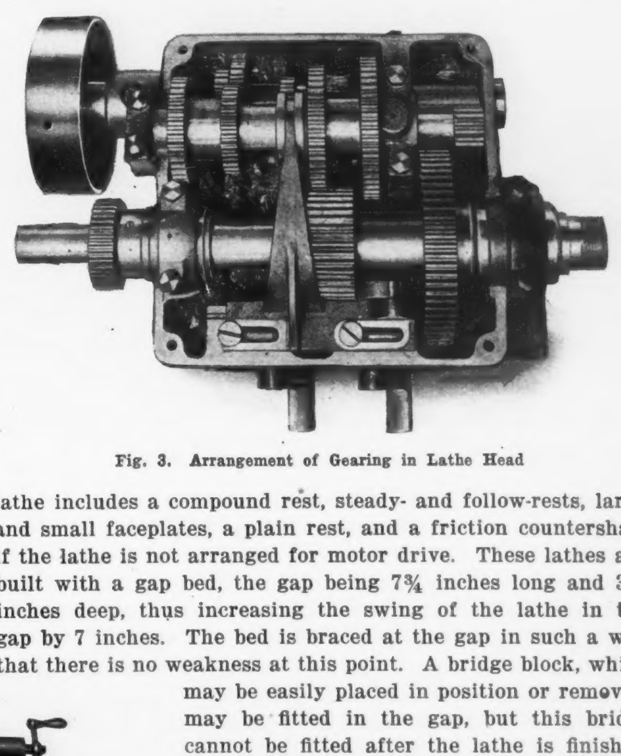


Fig. 3. Arrangement of Gearing in Lathe Head

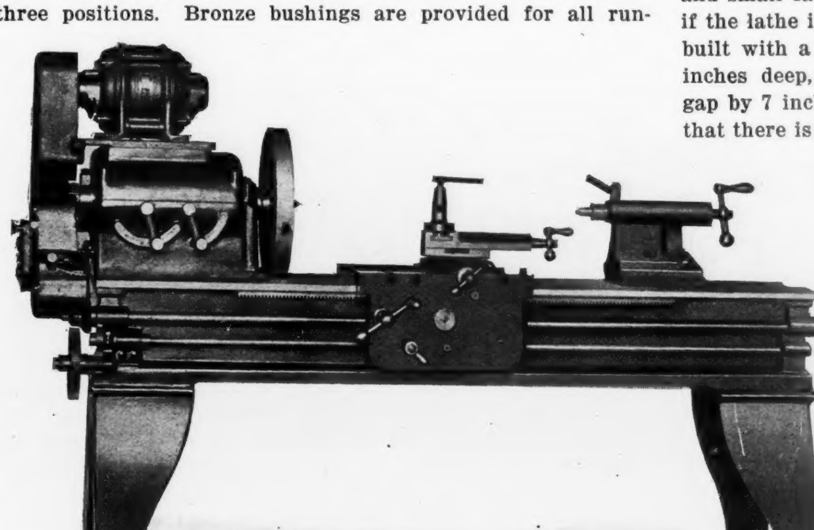


Fig. 1. Geared-head Lathe built in 13-, 14- and 15-inch Sizes by Sebastian Lathe Co.

ELWELL-PARKER TRUCK

Since building its first hand-operated elevating platform on an electric storage battery truck about five years ago, the Elwell-Parker Electric Co., Cleveland, Ohio, has developed two special electric lift trucks. The latest model of this type has incorporated many features and refinements dictated by actual service conditions. Both the electrical and mechanical construction of this type of truck, which is built in two sizes, are completed in their own plants. The tool is operated by two enclosed motors, each especially built to perform work of an entirely different character, *i. e.*, one to propel the truck and the other to electrically

Self-loading Electric Truck made by the Elwell-Parker Electric Co.

drive the elevator. The storage battery is carried in a covered compartment on top, close to the controller and above the vertical propelling motor. This motor is direct-splined to a single worm reduction on a four-pinion bevel differential. A contracting brake is located between the motor and axle and is spring-operated by the driver releasing his weight from one pedal, which forms half of the operating platform. The brake is capable of stopping the truck in its own length under all conditions of load and speed.

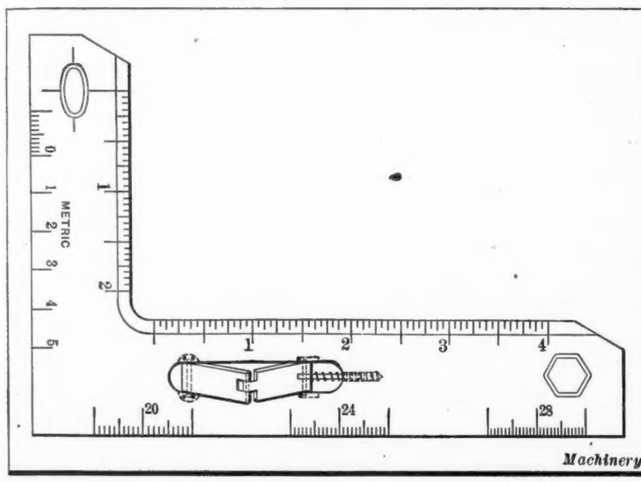
A circuit-breaker or connection between the controller and battery is actuated by the weight of the operator on a second pedal. This circuit-breaker is interlocked with the controller and will not close except when the latter is in the "off" position. Therefore, no fuse is required and the special motor will take the full battery power. The brake and circuit-breaker operate independently, so that the truck can be started on the incline without fully releasing the brake or blowing a fuse. The controller is self-returning to the neutral position whenever the handle is released. Thus the operator is afforded complete protection under both normal conditions or in emergencies. Drive to the axle is of the full floating type, and supports the truck frame of heavy springs. The driving shafts carry no weight and are removable through the wheels with 21½- by 3½-inch tires, which are also demountable.

A lever, which is adjustable for the operator's height, steers all four wheels. The steering tie-rods and knuckles are so located that difference in wheel angularity is compensated for, giving concentric steering when turning to right or left. All levers are bushed, and the pins are hardened and ground and held rigidly in the steering links. The steering knuckles are located over the tire center lines to give easy steering. These features, with independent operation of the brake and circuit breaker with no fuse, are exclusive Elwell-Parker construction details. The truck deck or platform is raised by means of a special enclosed motor which drives a worm lifting device or elevator. This lifting mechanism runs at slow speed in oil and needs attention only once or twice a year. A special switch is closed manually to lift the truck platform after having driven it beneath a separately loaded deck or platform. This results in an instant lift of 4½ inches to the load. This raises the load up above all floor obstructions and proves an advantage in crossing door sills, rails, or uneven floors or yards. When the load reaches the upper or lower limit of travel, an attachment to the platform opens the switch to the motor.

It is possible on this truck for the operator to instantly stop movement of the platform in either going up or down. This is an important improvement, for loaded platforms or goods may catch on obstructions or adjacent machines and do damage unless it is possible to stop at any point when elevating two tons. Storage batteries are furnished of a capacity to perform a day's work when traveling ten to twenty miles. These trucks are made in two heights to suit different conditions. The higher one is provided with larger wheels and is particularly well adapted for yard work. With a worm drive and worm lift, large clearances beneath, larger wheels and a reduced width and length, these trucks meet conditions in practically every industry.

WARE GRADUATED ANGLE SQUARE

R. B. Ware, 101 Northampton Ave., Springfield, Mass., is now making what is known as a graduated angle square, which is shown in the accompanying illustration. This instrument is intended for the use of draftsmen, and it is claimed that it may be used with equal facility by right- and left-handed men. It will be apparent that this is a 30- and 60-degree angle square, because, when placed with the beveled ends on the T-square, 30- and 60-degree angles may be drawn. Using the square with the beveled side down makes it very convenient for inking in—especially for dotted lines. This square is regularly furnished with divisions graduated to 1/16 inch on the inside, centimeters and millimeters at the end, and 20ths, 24ths and 28ths of an inch on the bottom edge. It is provided with the Ware "Pick-up" feature. As previously described in MACHINERY, this consists of a knuckle joint which presses through the slot in the square and pops up on



Graduated Angle Square made by R. B. Ware

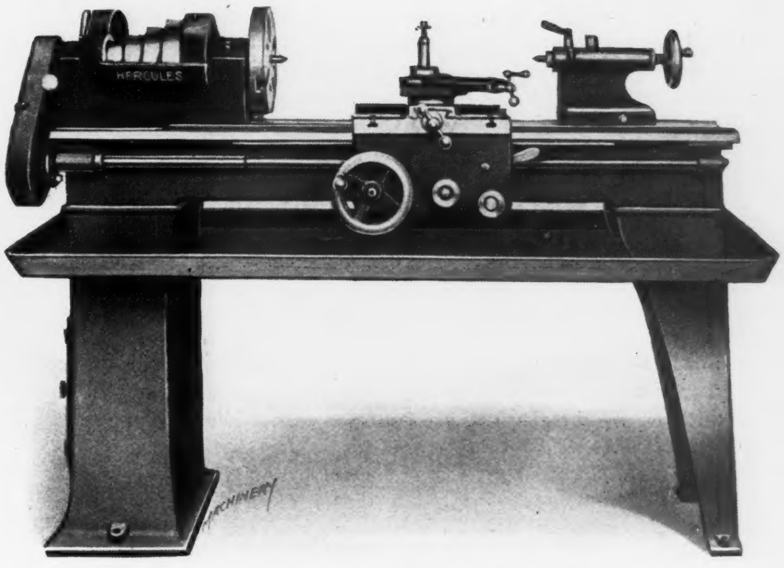
either side through pressure applied by a music wire spring. This pick-up always rises to the upper side of the square, but the square may be placed between the leaves of a book or have other articles laid upon it. In such a case the pick-up drops into the slot and takes no more room than if it were not there. This square is made in 2 by 4, 3 by 6, 4 by 8, and 5 by 10-inch sizes of 30- and 60-degree angles; and in 3 by 3, 4 by 4, 5 by 5, and 6 by 6-inch sizes of 45-degree angles.

LUSTER-JORDAN LATHE FOR TORPEDO AIR FLASK HEADS

The Luster-Jordan Co., Inc., Franklin Ave. and Washington St., Norristown, Pa., has recently built for the Spanish government a special lathe for turning the air flask heads on torpedoes. It was formerly the practice to turn these heads on a standard lathe, and the required radii of curvature on various surfaces of the work were obtained with radius attachments. Since the inside of one head may have from two to five different curves, it will be apparent that in order to handle this class of machining operations and produce accurate work, it might be necessary to use ten different adjustments of the radius attachment to machine both sides. On the special lathe built by the Luster-Jordan Co., a forming attachment is used on the tailstock, and in some instances a form-

ing attachment on both the carriage and tailstock. In this way the operation is greatly simplified.

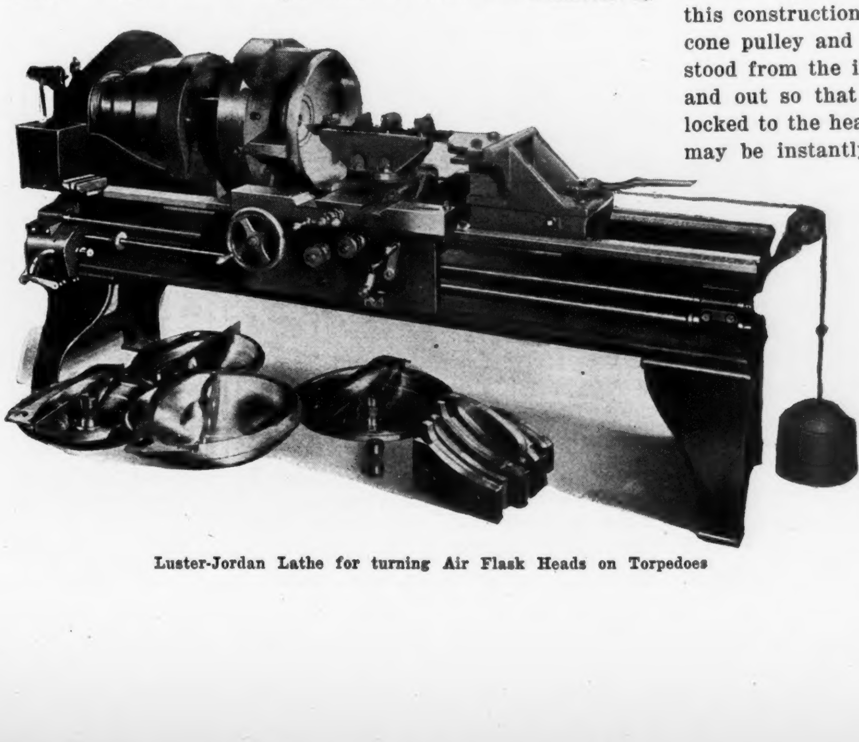
The toolpost on the lathe carriage has been made wider and heavier; and the upper part of the tailstock has been removed to provide for mounting a special forming attachment. This consists of a plate whose edge conforms to the contour of the air flask head to be machined. The toolpost has a straight slot extending across it, and in one side of this slot a cutting tool is carried, and in the other a forming guide, which runs in contact with the formed plate carried on the tailstock. Both the tool and forming guide have on their cutting edge and guiding edge, respectively, an accurate circular point, say 1/4 inch in diameter. The distance between the centers of these circles is 3/4 inch. The forming plate is marked "Center of Tool" and "Center of Work," and these two centers are 3/4 inch apart in order to register correctly.



"Hercules" 12-inch Screw Cutting Engine Lathe built by Himoff Machine Co.

Due to the fact that it is necessary to use a circular cutting edge in order to follow all around the work and get into the recesses, the condition arises that the form plate must have a different form from the finished air flask head. If, for instance, the curvature of the work conforms to a 16-inch radius at a certain point, the radius of the form plate for use in machining this head will not necessarily be 16 inches for the corresponding point, since the cutting tool does not always cut on the same point, but changes around the circular form of the tool. Therefore, it is necessary to develop each form plate according to the head for which it was made. Some of the heads have a decided transverse curve ending in a longitudinal curve, and it has been found necessary, in order to make the machine operate correctly, to disconnect the toolpost screw and connect with the feed of the carriage, so that when one feed is disconnected the other is thrown in without interruption. This result has been accomplished by splitting the screw operating the toolpost and connecting this attachment with the clutch on the carriage which operates the feed-screw on the carriage, thus making the machine practically automatic in operation.

A counterweight is connected to the carriage which supports the toolpost for boring the center of the torpedo head. The machine is equipped with a progressive boring tool, which is registered by the guide in the center of the form. The heads are gaged by inserting a plug gage into the center of the head, and the inside form of the head is registered from this plug gage by means of a flat gage. The outside form is gaged by another flat gage, which rests on the upper surface of the inner gage, thus gaging the inside and outside form and also the thickness of the head, where inaccuracy might result in serious trouble. By means of this machine it is possible to machine a smaller head 12 inches in diameter in approximately 6 hours, and a larger head 22 inches in diameter in from 10 to 14 hours. These figures were obtained in machining samples made of cast iron; forgings which are used in actual practice were not available. The machine is equipped with an oil pump and progressive feeds in the cross-slide to compensate for the different peripheral speeds.


Luster-Jordan Lathe for turning Air Flask Heads on Torpedoes

HIMOFF ENGINE LATHE

The 12-inch screw cutting engine lathe which is the subject of the following description has recently been added to the line of "Hercules" machine tools built by the Himoff Machine Co., 45-53 Mills St., Astoria, L. I. In working out the design of this machine it has been the aim to develop a lathe adapted for handling a wide range of work in tool-rooms and mechanical laboratories, in addition to the performance of manufacturing operations on light commercial work where accuracy is required. This lathe may be furnished with floor legs, bench legs, or mounted on an oil-pan; and it may be equipped for either belt drive from a countershaft or direct-connected motor drive.

The feed motion is positively driven by change-gears through a splined lead-screw, worm and gear, and then through spur gears to the rack. A friction is provided which may instantly be thrown in or out by turning a knob on the apron, and reverse is provided by shifting a lever in the headstock, which will feed the carriage either right or left or disengage the feed as required. The only wear which can occur in the lead-screw threads is when the screw is actually being used in the performance of thread cutting operations. Power cross-feed is provided by pulling out or pushing in a hand knob on the apron. The headstock casting is designed to afford mutual support for the front and rear spindle bearings, and this construction also serves to afford protection for both the cone pulley and back-gears. The idea will be readily understood from the illustration. The cone is finished both inside and out so that it is perfectly balanced, and this pulley is locked to the head gear by an improved locking device, which may be instantly secured or released without the use of a wrench. The hollow spindle is made of 50- to 60-point carbon crucible steel and ground to size. A chain oiling system insures positive lubrication. The thrust is carried by a hardened steel washer, which runs against the rear bearing, and adjustment is provided by a nut.

A wide range of thread-cutting operations may be performed on this lathe, the capacity being for cutting both right- and left-hand threads from 3 to 72 per inch, including the $11\frac{1}{2}$ pipe thread. An index and set of transposing gears may be furnished as a special equipment to provide for cutting screws with metric pitches.

The lead-screw on this lathe is carefully cut in a special lathe equipped with a master screw, which is frequently tested to insure accuracy. If a lathe is desired for cutting only metric threads, a metric lead-screw can be provided. The cross-slide is furnished with a standard compound rest as the regular equipment, but if so desired, a European toolpost may be furnished.

The tailstock is of the extension barrel type, providing clearance over the carriage bridge for turning short work. It is clamped in position by means of a special locking device, and the spindle has a self-discharging center. Side adjustment is provided to adapt the machine for the performance of taper-turning operations. The carriage is gibbed at both front and rear, and a simple locking device clamps the carriage to the bed when using the cross-feed. The cross-feed screw is supplied with a micrometer collar graduated to read to 0.001 inch, and an adjustable stop for the cross-slide is provided for use in screw cutting. The bed is a semi-steel casting, which is harder than ordinary cast iron, to give the required durability. This bed has two vees—one large vee to guide the carriage and the other placed at a lower level to guide the headstock and tailstock and avoid weakening the bridge.

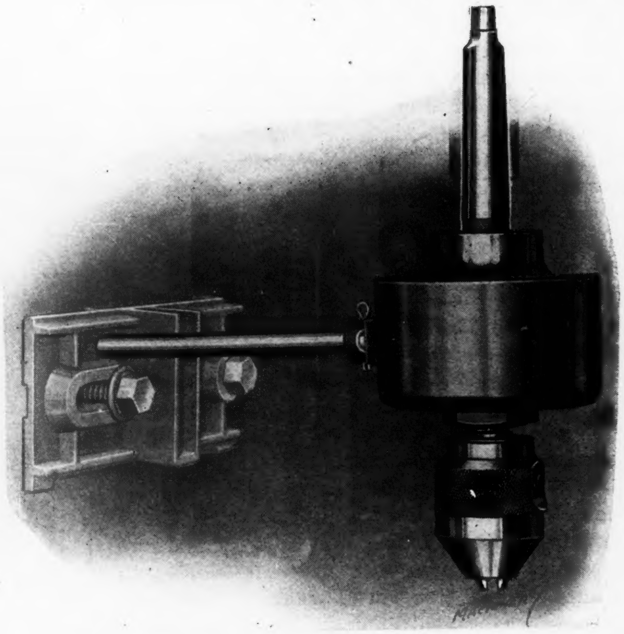
This lathe may be furnished with a taper attachment secured to the back of the carriage and arranged to travel with it. This attachment is always in position, ready for use, and is available for the full length of the lathe bed. It can be used with a plain or compound rest, and a micrometer cross-feed stop may be used on taper work. The swivel guide bar is graduated in degrees and inches, and has accurate adjustments from zero to 3 inches taper per foot, and tapers up to 12 inches in length may be turned at a single setting. This lathe can also be furnished with an automatic draw-in chuck attachment, consisting of a drawn-in tube with handle attached and bushings for collets. These bushings and the collets are made of tool steel, hardened and ground.

Principal dimensions of this machine are as follows: swing over bed, 12¼ inches; swing over slide on carriage, 7¼ inches; standard length of bed, 5 feet; capacity between centers for 5-foot bed, 30 inches; capacity between centers with tailstock overhung, 34 inches; dimensions of front spindle bearing, 1¾ by 4 inches; dimensions of rear spindle bearing, 1⅜ by 3 inches; taper of centers, No. 2 Morse; diameter of hole through spindle, 1 inch; back-gear ratio, 1 to 8.52; diameter of lead-screw, ⅞ inch; threads per inch on lead-screw, 8; countershaft speed, 300 R.P.M.; range of spindle speeds, 808, 500, 326, 214, 95, 59, 38 and 25 R.P.M.; range for thread cutting, 3 to 72 threads per inch; diameter of tailstock spindle, ½ inch; maximum movement of tailstock spindle, 4¼ inches; maximum opening of steadyrest, 3¾ inches diameter; length of carriage, 13½ inches; maximum movement of compound rest top slide, 4 inches; and net weight of machine with 5-foot bed, 760 pounds.

BICKNELL-THOMAS TAPPING ATTACHMENT

The Bicknell-Thomas Co., Greenfield, Mass., is now making what is said to be the first friction-driven tapping attachment built to fit any make of drill press. It has a capacity for handling taps from 3/32 to 1/4 inch in diameter, and has a friction mechanism inside the body of the attachment which is automatically adjusted by the amount of pressure the operator puts on the drill spindle when tapping. This makes a very sensitive drive and eliminates the sudden strain at the point of reversal, which is responsible for a large percentage of the taps which are broken in operation. Use of this friction mechanism overcomes the necessity of using a friction chuck, and so this tapping attachment is equipped with a plain chuck.

This company is also making a positive-driven tapping attachment designed for use on standard drill presses to overcome the necessity of reversing the machine spindle for backing out a tap. When the tap has been driven into the work to the desired depth, raising the drill spindle reverses the tap while the machine continues to rotate at full speed in the forward direction. An internal gear drive gives a reverse speed which is twice the tapping speed. All parts are made



Tapping Attachment made by the Bicknell-Thomas Co.

of steel, and those subject to constant wear are hardened. The clutch pins are made of tool steel, and the clutch dog is a tool steel forging, properly hardened and tempered. This attachment can be furnished with one of the Bicknell-Thomas friction chucks, in which the friction can be set so that in case the tap binds in the hole or is driven to the bottom of the hole, the friction will slip and prevent the tap from breaking. As shown in the illustration, the attachment may also be equipped with a plain chuck. Both styles of chucks are fitted with jaws which grip both the round shank and squared end of the shank, giving a very positive grip. This positive-driven tapping attachment is made in two sizes, with capacities for handling taps from 3/16 to 3/8, and 5/16 to 3/4 inch in diameter, respectively.

LUFKIN MECHANICS' READY REFERENCE TABLE

Information often required by machinists, toolmakers and other shop men in handling their daily work has been compiled in convenient form on a reference table recently added to the line of tools made by the Lufkin Rule Co., Saginaw, Mich. In order to make it suitable for carrying in a mechanic's pocket, this table, which is known as the Lufkin No. 97 rule, is made of flexible spring steel 1 7/32 inch wide by 6 3/4 inches long. On one side there appear machine screw tap sizes, each followed by the tap drill size number and its diameter in thousandths of an inch, and the corresponding body drill size number and its diameter in thousandths of an inch, *i. e.*, what is commonly known as the "outside diameter size." On the opposite side of the scale is a complete set of decimal equivalents of fractions, and at the foot of the rule a space of 1 inch

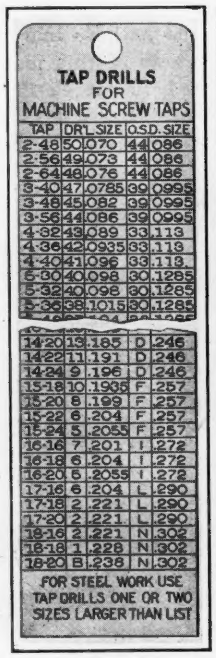


Fig. 1. Lufkin Mechanics' Ready Reference Table

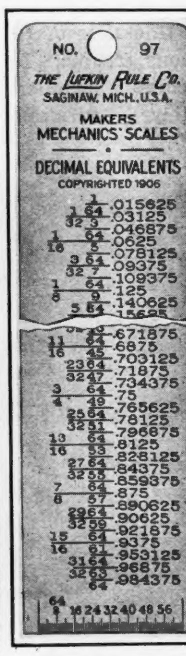


Fig. 2. Opposite Side of Reference Table shown in Fig. 1

graduated to 64ths. This rule has good legible figures, and as the figures and graduations are cut in steel, the rule will prove durable and not easily soiled. Combining in a single table tap and drill sizes and decimal equivalents, makes it unnecessary to refer to two tables, which is now customary. This new Lufkin No. 97 rule should prove a time saver and a thoroughly practical tool for those classes of work for which it is intended.

"SATCO" KEYLESS DRILL CHUCK

In working out the design of a quick-change keyless drill chuck which has recently been placed upon the market by the Steel-Art Tool Co., Elgin, Ill., attention has been paid to simplifying the mechanism as far as possible, the complete chuck consisting of only eight parts. Another feature is that this is a hand-operated chuck, which makes it possible to change drills while the machine is running at full speed without the operator running any risk of being hurt. The chuck centers the drill automatically and requires no keys or wrenches to tighten or release its powerful grip. It is normally open to its full capacity and can be reduced to the smallest capacity by simply holding the knurled sleeve against rotation of the spindle. In operation, a drill is slipped into the chuck and the knurled sleeve held until the jaws grip the drill; then as the load increases the jaws increase their grip in direct proportion. The chuck is released by striking the knurled sleeve in the direction of rotation, as shown in Fig. 2. There are three jaws in the chuck, which are made of tool steel, hardened and ground, and attention is called to the fact that the chuck is built up without working screws or threads of any kind. The chuck is made in five sizes, known as Nos. 0 to 4, inclusive, and have capacities of from zero to 1/8 inch, zero to 1/4 inch, 1/16 to 3/8 inch, 1/8 to 1/2 inch, and 1/4 to 5/8 inch, respectively.

Fig. 1. "Satco" Keyless Drill Chuck

Fig. 2. Method of releasing Drill from "Satco" Keyless Chuck

GRAND RAPIDS UNIVERSAL GRINDER

The Grand Rapids Grinding Machine Co., Grand Rapids, Mich., is now building a No. 1 universal grinding machine which is illustrated and described herewith. This is a companion machine to the Grand Rapids No. 2 universal grinder which was illustrated and described in the March number of MACHINERY. The No. 1 grinder is adapted for use in those plants where a satisfactory drill grinding machine is already available. This machine swings 9½ inches on centers and has a capacity for work up to 20 inches in length. It has a maximum longitudinal movement of 15 inches, transverse movement of 7 inches, and vertical movement of 6¾ inches. The knee, which carries the saddle, table and sub-table, swivels all the way around the main column, and the table also swivels through a full 360 degrees on the sub-table.

To provide for the performance of taper turning operations, the table is provided with a graduated scale reading to 1/16 inch taper per foot. Both the transverse and elevating movements are provided by means of Acme thread screws running in bronze nuts of liberal size. Both screws are provided with graduated dials reading to 0.001 inch per foot. The spindle is made of hammered crucible steel and is carried in self-oiling bronze bearings with means of easily adjusting for either radial or end wear. The loose pulley is equipped with a bronze bushing; and the column, spindle and similar parts are carefully ground to the required size. The machine is regularly equipped with a chuck, universal vise, internal grinding attachment, and a complete outfit of wrenches, dogs, grinding wheels, etc.

Grand Rapids No. 1 Universal Grinding Machine

NEWTON MULTIPLE-SPINDLE MILLING MACHINE

In the June number of MACHINERY a description was published of a multiple-spindle milling machine which had just been placed upon the market at that time by the Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa. Recently this firm has built another machine of very much the same design, which is illustrated and described in the following article. The spindle saddles are of similar design, having square lock bearings and adjustments made by taper shoes. The horizontal spindle saddles have the narrow guide construction to provide for controlling alignment, and the rail saddles have hand adjustment, reversing cross-feed and revers-

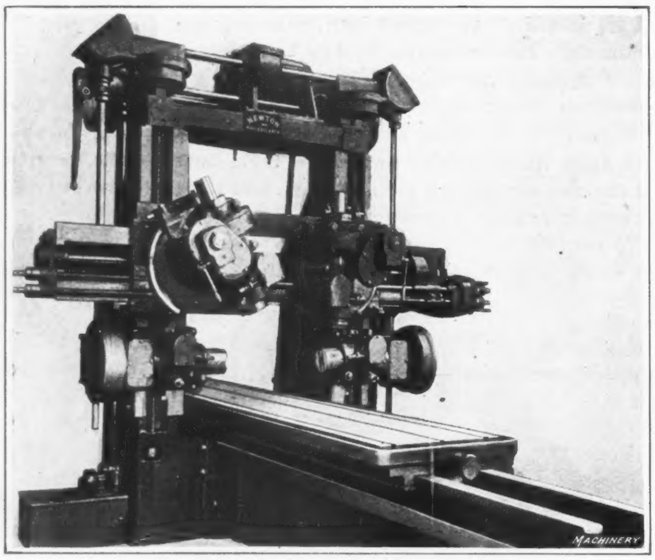


Fig. 1. Newton Multiple-spindle Milling Machine

ing fast cross motion. The saddles on the uprights are counterweighted by weights inside the uprights, and have only hand vertical adjustment.

Provision is made to clamp the rail to the saddles to provide power elevation and also to control alignment when a horizontal cutter-arbor is used and supported at its outer end. The cross rail has square bearings on the uprights, with narrow guide construction to control alignment; it is furnished with reversing power vertical adjustment, and supported by screws having bottom tension bearings. Twelve changes of reversing cross feed are available for the vertical spindles, covering a range of from 0.172 inch to 8½ inches per minute. There is also reversing fast power motion at the rate of 15 feet per minute. Each of these movements is controlled from the table mechanism. The spindles rotate in a clockwise direction unless otherwise specified, and there are nine changes of spindle speed, covering a range of from 16½ to 99 revolutions per minute.

The work-table is of heavy box-type construction, surrounded by an oil pan, and has square bearings on the base. Table feeds are independent of spindle speeds. Twelve feed changes are available, ranging from 0.355 inch to 13 inches per minute in both directions. These changes are obtained through gears in an oil-tight feed-box, cut bronze or steel gears being used, which are mounted on sliding sleeves controlled by latch levers fitted through the cover. The table movement is obtained through an iron or steel angular rack and a steel or bronze worm which rotates in a bath of oil. Provision is also made for hand adjustment of the table. Rapid traverse of the table is independent of the feed movements and spindle speeds, and is available at the rate of 30 feet per minute in both directions. The machine base is of heavy box-type construction, with a solid closed top and double cross ribs. Cheeks for the attachment of uprights are cast solid with the base; and the standard length of the base is 1¾ times the length of work which the machine is rated to mill. In working out the design, all control levers have been placed within easy reach of the operator.

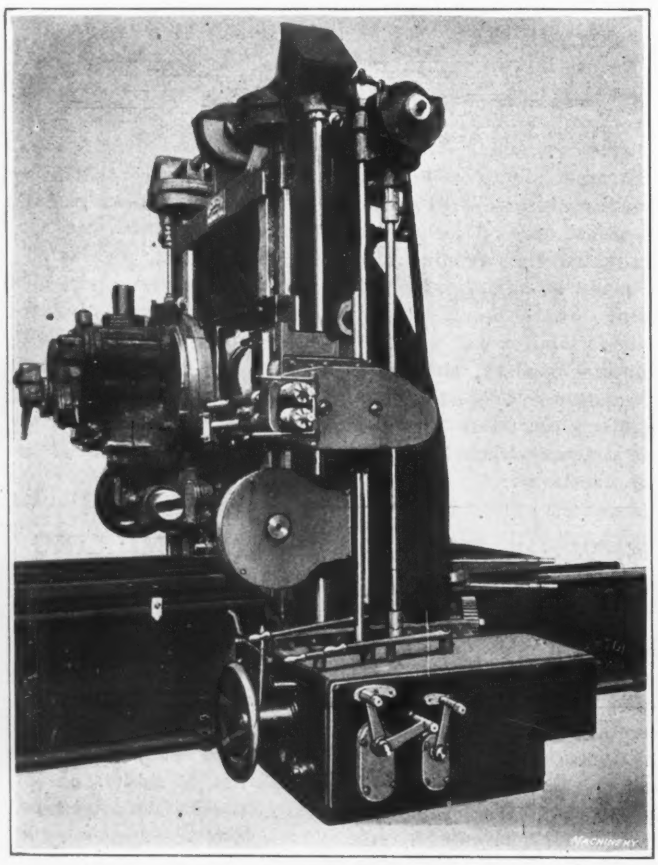
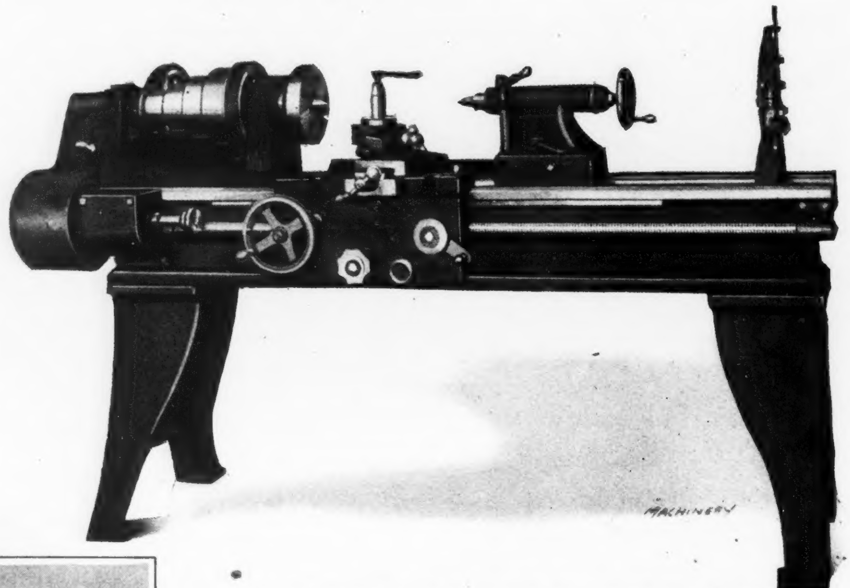


Fig. 2. Side View of Newton Milling Machine shown in Fig. 1



Screw Cutting Engine Lathe built in 14-, 16- and 18-inch Sizes by Canedy-Otto Mfg. Co.

CANEDY-OTTO ENGINE LATHE

One of the latest additions to the line of machinery built by the Canedy-Otto Mfg. Co., Chicago Heights, Ill., is a screw-cutting engine lathe built in 14-, 16- and 18-inch sizes. The 14-inch machine is built with either a 6- or 8-foot bed, and the 16- and 18-inch machines with either a 6-, 8- or 10-foot bed. The spindle on these machines is made of 50-point carbon steel finished by grinding and carried in bronze-bushed bearings. The carriage is gibbed at both the front and back, and all plain bearings on the machine are carefully scraped to surface plates. The gear-box is of the quick-change type, and in working out its design care was taken to combine the features of strength and simplicity. Three changes of feed are available. Regular equipment furnished with this machine includes large and small faceplates, compound-, steady- and follow-rests, two steel centers, change-gears for screw cutting, a double friction countershaft, and the necessary wrenches for making all adjustments.

Principal dimensions of the 16-inch lathe are as follows: swing over bed, 16½ inches; swing over carriage, 11¼ inches; size of front spindle bearing, 2⅜ by 4 inches; size of rear spindle bearing, 1⅞ by 3 inches; width of cone pulley belt, 2 1/2 inches; diameter of hole through spindle, 1 5/16 inch; size of cutting tool, ⅝ by 1¼ inch; diameter of nose of spindle, 2⅜ inches; diameter of tailstock spindle, 1¾ inch; length of carriage bearing on bed, 18½ inches; speed of countershaft, 125 revolutions per minute; distance between centers for 6-foot bed, 40 inches; and net weight of machine, 1600 pounds.

HARRIS OFFSET DRILLING ATTACHMENT

The Harris offset drilling attachment, which is illustrated and described in this article, is, as its name implies, an attachment for drill presses to drill, face and counterbore holes and bosses in out of the way places that cannot be reached by usual methods. It is valuable for use on standard lines of manufacture, such as automobile, muntion, railroad work, machine tool work and in jobbing and contract shops in general. This tool is made in eight sizes to fit every standard make and size of drill press or similar machines. It is not only a labor saver on many jobs, by permitting it to be done mechanically and thus avoiding the use of otherwise unhandy methods, but the tool is also said to be conducive to good workmanship. With this attachment, screw holes in pulleys may be drilled without weakening the rim by drilling through the rim, as shown in Fig. 2.

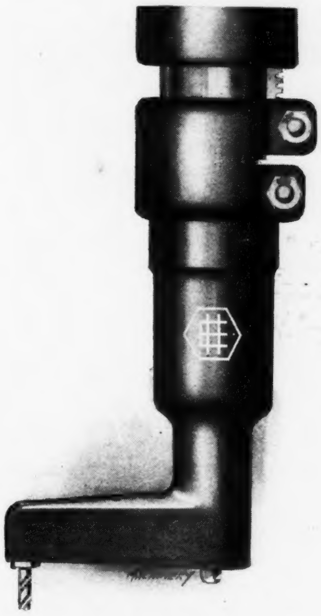


Fig. 1. Harris Offset Drilling Attachment

Oil-cup holes can be drilled by this method to supply lubrication to bearings without using a copper tube to carry the oil from some place where it is more convenient to drill by ordinary means for the oil-cup. Holes may be drilled in engine crankshafts for balancing purposes or for the distribution of lubrication. Bosses in frames, automobile parts, etc., may be faced off by the use of a counterbore, the operation being similar to that shown in Fig. 3, although much more difficult pieces of irregular shapes can be handled than that shown. It also presents a distinct advantage in permitting engineers designing machinery or apparatus to use advantageous designs which are sometimes avoided, due to lack of proper means of drilling in out of the way places.

Fig. 4 shows another use for the offset drilling attachment. These three operations will suggest to the engineer and mechanic the large number of varied uses to which this tool can be applied, thereby effecting economy both in the design of the apparatus upon which it is used, and in the performance of drilling and facing operations. One special use to which this offset drilling attachment has been put, and which may suggest others, is using an end-mill in the attachment on a drill press with a compound slide mounted upon its table for milling in an out of the way place which could not be reached with an ordinary end-mill or facing cutter in a milling machine or a profiler.

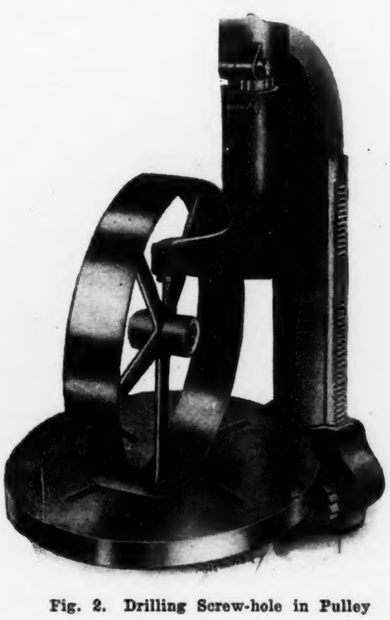


Fig. 2. Drilling Screw-hole in Pulley

If standard sizes of the offset attachment should for any reason not be suitable for the machine or work in hand, a special offset attachment may be made from a large number of special patterns. For instance, in cases where there is not room enough for the regular attachment to be used, or where a longer extension is required, by modifying the standard form an attachment to suit any special need can be supplied. One holder is furnished with each attachment, and the tool or drill is fitted to this holder. In grinding or changing tools, it is not advisable to remove the tool or drill from the holder, but the holder itself, with the tool, can readily be removed from the attachment, and as readily replaced. This attachment is so arranged that it may be swiveled around the center of the drill press spindle in any position which is found most convenient for the operation of the work. The drive is strong and powerful, being driven by a square shaft.

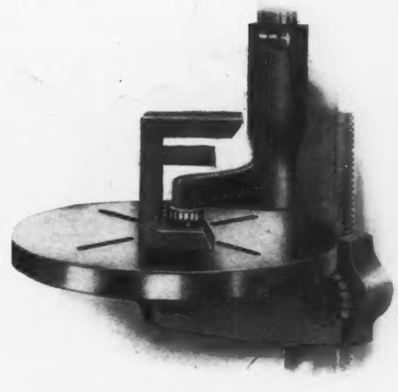


Fig. 3. Typical Work for Offset Drilling Attachment

The construction is rigid and strong, and the attachment will stand up to the work within its capacity. The tool-holder for holding the drill, counterbore or mill has a positive drive and means for holding the tool centrally, so that they will run true, and the change from one tool to another can be readily made, without disturbing the set up of the attachment in the drill press. The drill spindle runs in a hardened and ground tool steel sleeve and is provided with a ball thrust bearing. The driving gears in the attachment are made of carefully heat-treated vanadium steel gears, which are tested to a high degree of strength. This attachment is made by the H. E. Harris Engineering Co., 1047 Broad St., Bridgeport, Conn.

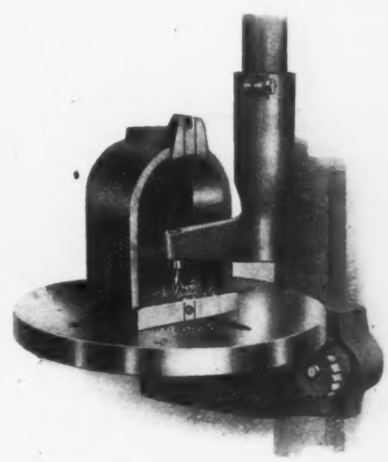


Fig. 4. Another Example of Offset Drilling

UNIVERSAL ELECTRIC TOOLS

The Universal Electric Co., 9 Oliver St., Newark, N. J., is now building the portable electric drill and grinder which are shown in Figs. 1 and 2. The drill is manufactured in three sizes, with capacities for handling drills up to 3/8, 1/2 and 3/4 inch in diameter, respectively, the two latter sizes being made in both single and two-speed types. In working out the design particular attention was paid to the obtaining of strength, durability and efficiency of operation. "Acieral" metal, made by the Acieral Co. of America, 26 Cortlandt St., New York City, was used wherever possible in order to keep the weight down to a minimum. These drills are provided with Cutler-Hammer switches; and the 3/8- and 1/2-inch sizes are equipped with Jacobs drill chucks, while the 3/4-inch size has a Morse quick-release taper socket.

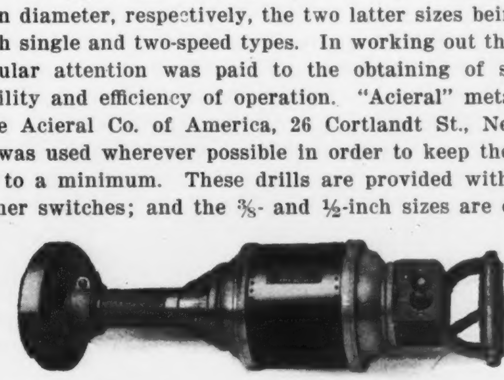


Fig. 1. Aerial Surface Grinder made by Universal Electric Co.

The electric grinder is what is known as an aerial surface grinder and is intended for the performance of heavy grinding operations of the kind that has to be done in foundries,

Fig. 2. Portable Electric Drill made by Universal Electric Co.

engine shops, etc. The motor is wound for two- or three-phase alternating current and develops ½ horsepower at a speed of 3575 revolutions per minute. This motor is equipped with SKF ball bearings, and the wheel bearings are lined with bronze and made adjustable for wear. The size of the grinding wheel is 6 inches in diameter by ¾ inch wide, and it is protected by an efficient guard. Care has been taken to place the operating switch in a convenient position to be manipulated by the operator's thumb without requiring him to release his hold upon the handle. As this grinder is often used without being suspended from the ceiling or the workman's shoulder strap, it was important to keep the weight as low as possible. The complete weight of the ½-horsepower grinder is only 31 pounds. After trying out several aluminum alloys, it was decided to adopt the use of an Acieral metal which is extensively used in aeroplane construction.

"SATCO" SAFETY LATHE DOG

With the view of avoiding accidents which sometimes occur through the hands or clothing of machine operators being

Fig. 1. "Satco" Lathe Dog

Fig. 2. End View of Dog, showing Arrangement of Jaws

caught by the usual form of dog used for turning work on lathe centers, the Steel-Art Tool Co., Elgin, Ill., has developed

Fig. 3. "Satco" Safety Lathe Dog in Operation

the safety lathe dog shown in the accompanying illustrations. Figs. 1 and 2 show two views of the dog, and in Fig. 3 the dog is shown in operation on a lathe. From these illustrations it will be apparent that the work is gripped by three jaws, and that there are two "tails" to provide for driving the work. As both jaws and tails are adequately protected, there is no chance of accidents resulting from a workman's hands being struck by the dog or from his being drawn into the machine by having a sleeve or other part of his clothing caught.

NEW MACHINERY AND TOOLS NOTES

Plain Milling Machine: Cincinnati Milling Machine Co., Cincinnati, Ohio. A 12-inch plain manufacturing miller adapted for the rapid production of small machine parts such as those which have to be machined in shops engaged in making rifles, typewriters, sewing machines, etc.

Journal Truing Machine: W. C. Dunn, 26 Hulbert Block, Cincinnati, Ohio. This is known as the "Pearce" journal truing machine, and although primarily intended for truing car journals it may be employed for numerous other purposes. The range of work handled covers journals from 3¾ by 7 up to 6 by 11 inches in size.

Pneumatic Hammer: Dayton Pneumatic Tool Co., Dayton, Ohio. This hammer is especially adapted for all kinds of chipping on castings, steel billets, boiler plates and structural iron. It is also suitable for use in calking and beading. The hammer has long bearing surfaces and is simply designed, consisting of only twelve parts.

Transfer Truck: Holyoke Truck Co., Holyoke, Mass. A line of transfer trucks of the elevating type. These trucks are made of metal throughout, and are constructed without springs or parts likely to get out of order. Trucks of both the three- and four-wheel types are made, and the wheels are fitted with Hyatt roller bearings.

Axle Drilling Machine: Baker Bros., Toledo, Ohio. A two-spindle axle drilling machine designed for simultaneous drilling of both ends of the front axles of automobiles. This machine comprises two units of the Baker No. 314 standard single-spindle high-speed drill mounted on a bed of sufficient size to accommodate the two machines.

Grinding Wheels: White Heat Products Co., Frazer, Pa. A grinding wheel in which the abrasive grains are fused together to obtain a very strong wheel that will cut fast and last for a comparatively long time. The abrasive grains used in these wheels are imported from France where they are made from a French bauxite and are said to be fast and free cutting.

Expansion Joint: R. D. Nuttall Co., Pittsburg, Pa. A one-piece machined expansion joint which is intended to be used as a substitute for loops and U-bends, and stuffing-box and long sweep expansion joints. The action of this new Nuttall joint is similar to that of an accordion or bellows, limiting bolts being provided to prevent expansion beyond safe limits.

Floating Reamer Holder: Victor Tool Co., Waynesboro, Pa. This holder is intended for carrying reamers used in turret or automatic lathes and on vertical or horizontal boring mills. The design has been developed along simple lines and there are few parts in the tool. These holders are made in standard sizes with either taper or straight shanks; special sizes are made to order.

Drilling Machine: W. W. Machine Works, Chicago, Ill. An upright drilling machine especially adapted for handling small and medium sized pieces. In working out the design of this drill care has been taken to develop a machine possessing ample strength and durability. The machine is 68 inches high; it occupies a floor space 20 by 30 inches in size, and will drill the center of a 15-inch circle.

Grinding Machines: McDonough Mfg. Co., Eau Claire, Wis. Two machines known as the "Sterling" grinders. One of these is a universal tool and reamer grinder, and the other an 18- by 50-inch plain, universal or crankshaft grinder. On the tool grinder a base of the cabinet type is used with a cylindrical column at the top. The swivel frame is bored to fit the column, and the vertically adjustable knee is mounted on a 45-degree slide.

Portable Oil Tank: Gilbert & Barker Mfg. Co., Springfield, Mass. To provide for convenient handling of oil in machine shops, this company is now making a portable pump and tank outfit. The tank is made of sheet steel with the seams oxy-acetylene welded; and the frame and axle are made of wrought iron welded into one piece and mounted on 6-inch malleable iron wheels. The pump can be set to fit any small size container without overflow.

Oil Switch: Crocker-Wheeler Co., Ampere, N. J. An oil switch suitable for use in starting alternating-current motors

up to 10 horsepower, by connecting them directly to the supply circuit. These switches are also arranged for reversing operations, and are characterized by simple and rugged construction. The switch consists of one set of moving and three sets of stationary contacts, an arrangement which gives a large break on two points for each pole.

Shaper Sawing Attachment: J. A. Moller, New Rochelle, N. Y. A sawing attachment for a shaper, which is intended for use in the manufacture of dies, gages, jigs, fixtures and similar work. Among the advantages claimed for this attachment are provision made for clamping the stock positively in the vise of the shaping machine, the positive control provided for the saw when actuated by the shaper ram, and the ability to adjust the blade in all directions.

Direct-reading Caliper: Fred Todt, 17 Jenks St., Springfield, Mass. This instrument is similar in type to a vernier caliper. Mounted on the slide is a graduated dial on which are two pointers spaced 180 degrees apart, which rotate over a double graduated dial. The outer scale has 500 divisions and the inner scale 32. A ½-inch movement of the slide along the bar causes a complete revolution of the pointers, thus making the instrument read by one thousandths or by sixty-fourths of an inch.

Combination Tool: Hall Mfg. Co., Abington, Mass. A combination counterbore, end-mill, hollow-mill, and boring tool which is adjustable to meet requirements of the work. These tools are made in various sizes and each size has a wide range of adjustment. The blades are ground on all four edges so that the same set of blades serves for counterboring, end-milling, hollow-milling or boring. These blades are clamped in movable jaws to provide for making the required adjustment.

Crane: Champion Crane Co., Guardian Bldg., Cleveland, Ohio. A crane with a 15-ton hoisting equipment designed for operation by either direct or alternating current. The crane equipment is furnished with a number of automatic safety devices to provide for protection of the operator and prevention of damage to the machinery. The hoist mechanism has an automatic switch limiting the upward travel of the hook, while the trolley is designed to permit installation of any standard safety device.

Plate Punching Machine: Ironton Punch & Shear Co., Ironton, Ohio. A large double plate-punching machine built for the Jones & Laughlin Steel Co. This machine consists of two punching machines, each of which cuts a 1⅜-inch hole through soft steel plates 1⅜ inch in thickness, when the two machines are working in unison. The machines are mounted on a bed plate and arranged so that the distance between centers can be adjusted from 5 to 14 feet. Between the two machines is a table for carrying the work.

Band Saw: Napier Saw Works, Inc., Springfield, Mass. This machine is built in three sizes with capacities for handling work up to 6 by 6, 8 by 8, and 10 by 10 inches in size. The base of the machine is of the cabinet type with a flange at the top to retain cutting compound which is pumped from a reservoir in the base. All bearings are lined with either bronze or babbitt. The arm tilts to provide for feeding the saw to the work, and to counteract the possibility of bending, this arm is built up with two channel sections and a truss rod.

Sheet Metal Tester: Pittsburg Instrument & Machine Co., Pittsburg, Pa. A device for testing the drawing, stamping, compressive and folding qualities of sheet steel, iron, copper, brass, aluminum, silver, German silver, nickel, zinc or plated metals. This little machine is furnished with means of working the metal and it has graduations which permit measuring the thickness of material and depth of impression to 0.001 inch. In addition to its use for testing sheet metal, this machine may be used for conducting wire tests if it is furnished with a special die.

Universal Turret Lathe: W. K. Millholland Machine Co., Indianapolis, Ind. In working out the design of this machine, particular attention has been paid to the provision of means for facilitating the setup, obtaining rapid production on bar and chucking work, and to make the machine easy to operate and capable of producing accurate work. To provide power feed to the cut-off and apron, seven gears and a reversing worm and wheel transmit power to the cut-off and longitudinal feed. Feeds to the cut-off and apron are independent and selective, and either one or both of these motions can be engaged or disengaged with automatic stops.

Tapping Attachment: Wahlstrom Tool Co., 5520 Second Ave., Brooklyn, N. Y. A tapping attachment adapted for threading holes up to ⅜ inch in diameter. In working out the design of this tool particular care has been paid to developing a mechanism which is sufficiently sensitive to reduce breakage of taps to a minimum. The attachment is made with either a No. 2 or No. 3 taper shank which fits the drilling machine spindle, and it is furnished with a holding rod to prevent turning, this rod extending to a slide on the column of the machine. This attachment is operated by using the spindle handle on the machine, and reverse motion takes place simultaneously with an upward movement of the drill spindle.

ALUNDUM, CRYSTOLON REFRACTORIES

Alundum, an aluminous abrasive, in its purest form, contains more than 99 per cent aluminum oxide. Its high melting point, 2050 degrees C., high heat conductivity and electrical resistant qualities make it particularly adaptable in the manufacture of refractories. Crystolon, too, gives excellent results for certain work, such as muffles and tubes used under special conditions. Cores, tubes and muffles are used mostly in the construction of small electric furnaces and for general laboratory work; large electrical manufacturers use the tubes in their furnaces for the annealing of tungsten and molybdenum wire. Alundum cores are corrugated to accommodate the resistor; after the resistor is in place, alundum cement is applied around the entire construction. In this way the wire is fully protected and will not corrode under the most severe conditions, since the alundum cement, being of practically the same material as the core itself, is chemically inert.

The interruption of the usual supply of porcelain pyrometer tubes from abroad led to the development of alundum pyrometer tubes, which are guaranteed to be impervious to gases under a wide range of temperatures. They have the added advantage of possessing a surface that does not soften at the temperatures under which they are used and also prevent materials with which they come in contact from adhering to them during their use. They can be supplied, with or without collars, in lengths ranging from 6 to 48 inches. Because of their high thermal-conductivity, the tubes give accurate readings more quickly than a porcelain tube.

Alundum crucibles, cones and dishes are supplied in three degrees of porosity for filtering purposes and have given the greatest satisfaction where the filtration of chemically active solutions is involved. The cones are shaped to fit into the ordinary 60-degree funnel and are held properly in place by stretching a rubber gasket over the top of the funnel before introducing the cone. In steel-plant laboratories, where a great many tests are conducted daily to determine the carbon content in the product, alundum combustion boats have given excellent service.—*Grits and Grinds.*

* * *

HEAT-TREATMENT OF CHAIN CABLE

An exhaustive investigation of the heat-treatment of wrought-iron chain cable was recently presented to the American Society of Mechanical Engineers by Messrs. W. W. Webster and E. L. Patch, the main point under investigation being the causes of the comparative weakness of power-forged wrought-iron cable. The investigation became necessary after the steam-hammer process replaced hand forging, in 1914, in the United States navy yards. The power process was satisfactory to the extent that it effectively and cheaply welded the chain, but unsatisfactorily in that the chain, though apparently perfect, would not meet the breaking-strength requirements, while the hand-welded chain was successful under test, although it was not so thoroughly welded as the hammer-welded. One explanation of this phenomenon is: The hammer-welded link is so stiff, due to the extra work put on it, that the shearing stress can build up in the quarters to such a degree that the link will fail by shearing, whereas the hand-welded link is soft and ductile enough to deform under the shearing stress, failure occurring later, due to a combination of shear and tension when a higher tensile load is applied.

A very thorough and interesting investigation was made to ascertain whether by a simple heat-treatment the power-forged chain could be put into a reliable condition. The material used was refined iron that contained 0.1 per cent of carbon, 0.1 per cent of silicon, 0.008 per cent of sulphur, and 0.085 per cent of phosphorus. The practice of annealing is not commended, but heating to 950 degrees C. and cooling in air decreases the tensile strength and yield point, and increases the ductility of the metal and its resistance to shock. But this treatment increases the strength as well as the ductility and resistance to shock of the link as a whole. Prolonged heating and protracted cooling reduce the resistance to impact. Heating to lower temperatures than 950 degrees C. does not give such good results, and no advantage is gained by going beyond this temperature.

THE NATION'S INDUSTRIES MOBILIZED FOR WAR

PRICE REGULATION OF WAR NECESSITIES—ORGANIZATION OF BOARDS AND COMMITTEES

BY L. J. F. MOORE [1]

IN spite of criticism, it is the fact that the government has made extraordinary progress in mobilizing the great and varied industrial activities of the nation for war purposes. The organization of the War Industries Board was a great step toward centralization and the quick and effective application of executive power. At the head of this great war body is Frank A. Scott, so well known in the machine-tool industry. Associated with him are R. S. Brookings, B. M. Baruch, R. S. Lovett, F. F. Fletcher, P. E. Pierce and Hugh Frayne. This board has real power, while the Council of National Defense, important as it was and still is, was purely advisory in function; and while its recommendations were heeded, so much of its activity went into preliminary organization that its effect was not felt to any great extent in practical results. But the splendid organization and the vast amount of data compiled by the Council are now available for the War Industries Board, which is speeding up every line of war industrial effort and getting results every day. The subcommittee of the Council of National Defense, whose function is to formulate the problem for the War Industries Board to solve, are as given in the list.

These various committees will continue their valuable work and are depended on by the War Industries Board for the information and data it requires. The actual purchasing is under the direction of some individual of the War Industries Board, as, for instance, the purchase of machine tools and gages for government shops and work is under the supervision of Robert S. Brookings. This method of purchase will succeed that in which the various firms provided themselves with machine tools and gages. The third step will possibly be the commandeering of machinery for the use of the government under the direction of the War Industries Board, and some means of avoiding this last step will very soon be considered by the War Economies Board under the supervision of A. W. Shaw.

Frank A. Scott's Message to the Machine Tool Industry: "Speed in Accomplishment Should be Our Motto."

(By Telegraph to Machinery, New York.)

Washington, D. C., August 24, 1917.

An important part of the task assigned to the War Industries Board is to study the methods to increase production, including the creation or extension of industries demanded by the emergency, and the sequence and relative urgency of the needs of the government services. It is easy to see how closely these duties are related to the machine tool industry of our country. Modern war is very largely a matter of machinery, and while in our country there exists the greatest aggregation in the world of machine tool equipment, it is not all adapted to war needs. Therefore new equipment and much readjustment will be necessary. It is the hope of the board, and the confident expectation, that American machine tool manufacturers will meet new demands with all possible energy. Speed in war is essential to success. Machinery adapted to our needs is necessary if we are to attain speed in production. While a commission of the War Industries Board will arrange purchases for the government, the actual work of contracting and buying will continue as heretofore in the several departments established by law. It is clearly within the power of the government to take over and operate manufacturing plants necessary for war purposes, but it is not the present purpose of the War Industries Board to encourage the establishment of such a policy. It is obvious that except in special cases the government can be better served through contractual relations with the private owners of factories. The activities of the priority division of the new board will assist greatly in forwarding the work for the government in the order of its importance. Naturally considerations of economy and convenience in the several

Prices and Contracts

In the important matter of price regulation for war necessities, both for America and her allies, Judge Lovett states that the board expects no trouble in dealing with manufacturers, but has considered all phases of the question and has formulated plans to enforce its regulations. No definite declaration is made as to the methods to be adopted, but there is the strongest intimation that drastic steps, even requiring legislation for their enforcement, were considered, and the government may ask for power to commandeer and purchase necessities not included in the Food Control Bill.

The status of existing contracts held by American manufacturers for munitions and war supplies for the Allies is still in doubt. Whether the price regulations to be enforced by the War Industries Board will apply to them or whether the contracts will be abrogated, Judge Lovett has not yet stated. It is understood, however, that in the matter of fixing prices for future war necessities, the "just price" to be determined will be based on President Wilson's public statement of July 12:

> By a just price, I mean a price which will sustain the industries concerned in a high state of efficiency, provide a living for those who conduct them, enable them to pay good wages, and make possible the expansion of their enterprises which will from time to time become necessary as the stupendous undertakings of this great war develop.

Aircraft Production Board, Howard E. Coffin, chairman.

Committee on Coal Production, F. S. Peabody, president, Peabody Coal Co., Chicago, chairman.

Commercial Economy Board, A. W. Shaw, president, A. W. Shaw Co., chairman.

General Munitions Board, Frank A. Scott, Warner & Swasey Co., Cleveland, Ohio, chairman.

Subcommittee on Army Vehicles, William Butterworth, Deere & Co., chairman.

Subcommittee on Armored Cars, Col. J. H. Rice, Ordnance Dept., United States Army.

Subcommittee on Emergency Construction and Contracts, W. A. Starrett, Starrett & Van Fleet, chairman.

Subcommittee on Optical Glass, Dr. R. A. Millikan, National Research Council.

Subcommittee on Machine Guns, B. M. W. Hanson, Pratt & Whitney, chairman.

Munitions Standards Board, Frank A. Scott, chairman.

Subcommittee on Gages, Dies, etc., F. C. Pratt, General Electric Co., Schenectady, N. Y., chairman.

Subcommittee on Army and Navy Artillery, S. M. Vauclain, vice-president, Baldwin Locomotive Co., chairman.

Subcommittee on Fuses and Detonaters, E. A. Deeds, Engineering Laboratories, Dayton, Ohio, chairman.

Subcommittee on Small Arms and Munitions, J. E. Otterson, Winchester Arms Co., chairman.

Subcommittee on Optical Instruments, Frank A. Scott, chairman.

Subcommittee on Army and Navy Projectiles, W. H. Van Dervoort, president, Root & Van Dervoort Engine Co., E. Moline, Ill., chairman.

Cooperative Committee on Automotive Transport, Karl W. Zimmerschied, of General Motors Co., Detroit, Mich., vice-chairman.

Cooperative Committee from National Industrial Conference Board, L. A. Osborne, vice-president. Westinghouse Electric & Mfg. Co., Buffalo, N. Y., chairman.

[1] MACHINERY's Staff Correspondent.

Cooperative Committee on Brass, Charles F. Brooker, president, American Brass Co., Ansonia, Conn., chairman.

Cooperative Committee on Copper, J. D. Ryan, president, Anaconda Copper Co., 42 Broadway, New York City, chairman.

Cooperative Committee on Steel and Steel Products, Elbert H. Gary, chairman, United States Steel Corp., 71 Broadway, New York City, chairman.

Subcommittee on Alloys, James A. Farrell, president, United States Steel Corp., 71 Broadway, New York City, chairman.

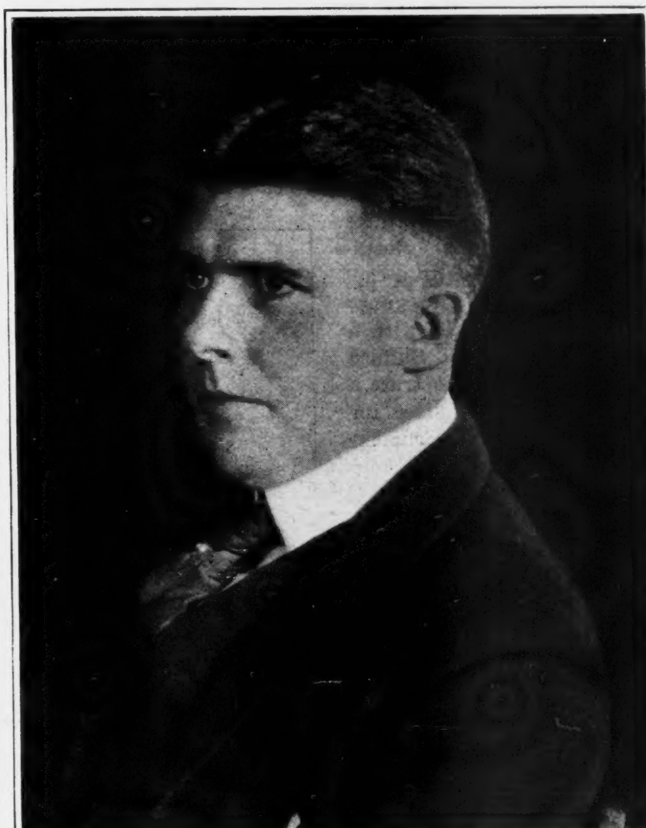
Subcommittee on Pig Tin, John Hughes, assistant to president of United States Steel Corp., chairman.

The establishment of this just price to the government and its allies, and, if necessary, to the public, will be the first result of the work of the War Industries Board, its Central Purchasing Commission, working with the Federal Trade Commission, which is to determine production costs, the Food Administration in its special field, and the Shipping Board, which will soon control freight rates and all shipping, together with the Export Council. Manufacturers and users of machine tools and other metal-working equipment are deeply interested in this matter of price regulation and in the manner of awarding governmental contracts.

In certain divisions of the work, notably in the case of air-plane production, the contracts are no longer awarded as the result of purely competitive bids. They are placed in accordance with the results of a survey made of the resources and ability of all plants throughout the country. But despite the fact that these contracts have been virtually assigned to the manufacturers on a basis of prices to be adjusted later, the various plants have had to furnish their equipment as private parties. The great difficulty in procuring the necessary additional machinery has had to be solved by each concern. This brings up the question as to how far the government will go in commandeering the production of private plants manufacturing machine tools, but no decision has as yet been announced by the Priority Board, which has this phase of the problem under consideration.

In the manufacture of field guns, another method has been adopted. The formation, at the suggestion of the government, of companies largely composed of manufacturers of metal-working machinery has resulted in the incorporation of the Wisconsin Gun Co., of Milwaukee, Wis., the Northwestern Ordnance Co., of Madison, Wis., and the Root & Van Dervoort Engine Co., East Moline, Ill. The same suggestion has also been made to the Niles-Bement-Pond Co., and the Otis Elevator Co. It is understood that the Bullard Machine Tool Company, of Bridgeport, Conn., will also operate a gun plant on the same conditions. Although no actual promise has been made, the government has intimated that it will take over ordnance plants that are being financed by these various companies and operated at no profit to themselves in the manufacture of field guns and ammunition.

trades involved as well as the necessities of the situation will be elements entering into the priority activities. To "win the war" will be the moving impulse in all the work of the board, and the machine tool industry enjoys to a unique degree the oppor-



Frank A. Scott

tunity to contribute to success. Speed in accomplishment should be our motto until the end.

FRANK A. SCOTT,
Chairman War Industries Board.

Subcommittee on Steel Distribution, James A. Farrell, president, United States Steel Corp., chairman.

Subcommittee on Scrap Iron, Eli Joseph, of Joseph, Joseph & Bros., New York City, chairman.

Subcommittee on Production Engineering, Dr. Hollis Godfrey, chairman.

Subcommittee on Construction Engineering, Dr. Hollis Godfrey, chairman.

Committee on Labor, Samuel Gompers, president, American Federation of Labor, Washington, D. C., chairman.

Subcommittee on Mediation and Conciliation, V. Everit Macy, president, National Civic Federation, chairman.

For general contract work, however, an immense amount of which the government will have to let shortly, the recommendations of the Interdepartmental Cost Conference will be adopted. The report gives a comprehensive system for the letting of contracts and recommends very strongly, in preference to all other methods, the straight purchase-and-sale prices wherever practicable. The experience of the British government in the cost-plus-profit plan was considered by the conference, but it decided that the purchase-and-sale contract method was superior. The five forms for the letting of contracts recommended to the War Industries Board by this conference are as follows:

1. Where fair terms can be obtained, contracts should be in the form of straight purchase-and-sale contracts at fixed prices.
2. A standard form of straight purchase-and-sale contract at a fixed price should be adopted for use wherever practicable.
3. In cost-plus contracts, a fixed profit of a definite sum of money per article should be agreed upon instead of a percentage of cost.
4. In cost-plus contracts, the fixed profit agreed on should be subject to adjustment, so that the contractor may share in the saving of, or be charged with part of the excess of, actual cost over estimated cost.
5. A standard form of cost-plus contract should be adopted for use wherever practicable.

The following items were considered in terming what constitutes fair terms: The quality and quantity of the articles purchased. Whether or not the plant is adaptable to business other than war business. The duration of the job and the length of time the contractor's plant and capital will be tied up; also the amount of capital tied up in comparison with the particular output contracted for. The possibility of fluctuations in material and labor costs, with attendant risk to the contractor. Loss in commercial business by taking government work, which must be given precedence; disarrangement in plant organization and labor conditions. Comparison with prices of other manufacturers, competitive bidding, etc. The prosperity of the trade and of the particular contractor.

In determining the standard form of straight purchase-and-sale contracts, the following clauses should be incorporated: Method of delivery, storage of production, shipment to point designated; United States to pay for raw material when delivered to contractor; United States to have the right itself

to supply material and component parts; United States to adjust price on increased material costs above estimated costs; United States to adjust price on increase in labor costs; liquidated damages; war termination clause.

Cost-plus contracts will be necessary in such cases as: Where the production is novel and the contractor has had no past experience upon which to base a price; for example, steel helmets, large caliber guns and shells for same, aeroplane motors and the like. Where production involves difficult and complicated manufacturing effort subject to changing plans and specifications, or wide fluctuations in material costs; for example, steel and wooden ships, aeroplanes, optical glasswork, and the like. Where the contractor, though deserving of confidence, lacks sufficient working capital and plant equipment to carry through the job. Engineering or building jobs for which the cost-plus contract has for many years been standard.

The application of these well-planned methods will remove obstacles that have blocked the progress of the committees in charge of the production of war supplies and will facilitate the awarding of contracts held up by confusion about prices. Under the Central Purchasing Committee of the War Industries Board the work has been speeded up, and with the vast powers now entrusted to the President, red tape has disappeared and results are quite amazing.

* * *

GUN BUILDERS FOR THE GOVERNMENT

Reports have been received that the following concerns have taken contracts for building heavy guns for the United States Government, or are making plans for that purpose: Northwestern Ordnance Co., Madison, Wis., incorporated with a capital stock of $100,000 for manufacturing 4.7-inch field guns; Tacony Ordnance Corporation, Tacony, Pa., organized with a capital stock of $100,000 to forge 6-inch howitzers; Bullard Machine Tool Co., Bridgeport, Conn., preparing to construct a plant for government gun work. Other plants organized for heavy gun manufacture or contemplating such government work are the Wisconsin Gun Co., Milwaukee, Wis.; the Inland Ordnance Co., Bedford, Ohio; the Symington-Anderson Co., Rochester, N. Y.; the American Brake Shoe & Foundry Co., Erie, Pa.; the Otis Elevator Co., New York City; and the Niles-Bement-Pond Co., New York City. The Wisconsin Gun Co. of Milwaukee was organized and incorporated with a capital stock of $100,000 by officers of the Kearney & Trecker Co., the Cutler-Hammer Mfg. Co., the Northwestern Malleable Iron Co., the Bucyrus Co., and Power & Mining Machinery Co. to build 3-inch field guns.

* * *

PAPER TUBES AND SACKS

Paper tubes for liquids and gases are one of the novelties that the dearth of metals has helped to develop. According to the process of A. von Valois, the paper is rolled to the desired wall-thickness and diameter and the seams are glued together and coated. Tubes kept full of water for weeks have shown no swelling or loss of strength, are not attacked by coal gas, weigh only one-sixth as much as lead pipes, and stand more than three times the bursting pressure. The joints are made by putting sleeves over the tubes and filling some cement into the annular space; the joint, however, will not stand the internal pressures of unjointed sections. They will withstand an external pressure of 400 pounds per square inch, which is sufficient to admit of burying these pipes in the ground.

In another type of tube, known as the "Pertinax," the water is impregnated with synthetic rosin and is rolled under tension. The water tests of these tubes have not been quite satisfactory. There was absorption of water when closed tubes were filled with water and kept standing. As oil does not attack synthetic rosin, however, small oil conduits might be made of "Pertinax" paper, which can be shaped into tubes as small as 0.200 inch in diameter.

Paper-yarn sacks for sand are strong enough, when wet, if the dry yarn has been impregnated at 50 degrees C. with a solution containing 24 ounces of glue, 0.1 ounce of tannin, and 0.1 ounce of sodium silicate of density 1.345. The tensile strength of the warp of strips of the dried material is 560 pounds per square inch untreated, and 650 pounds treated; after soaking in water twenty-four hours, the figures are 375 pounds and 480 pounds; and after redrying, 580 pounds and 640 pounds per square inch. The weft figures were a little lower throughout. Favorable results were also realized with successive impregnations, first with cold basic aluminum formate, then with glue, and again with the formate. Mixtures of soap and glue did not answer.

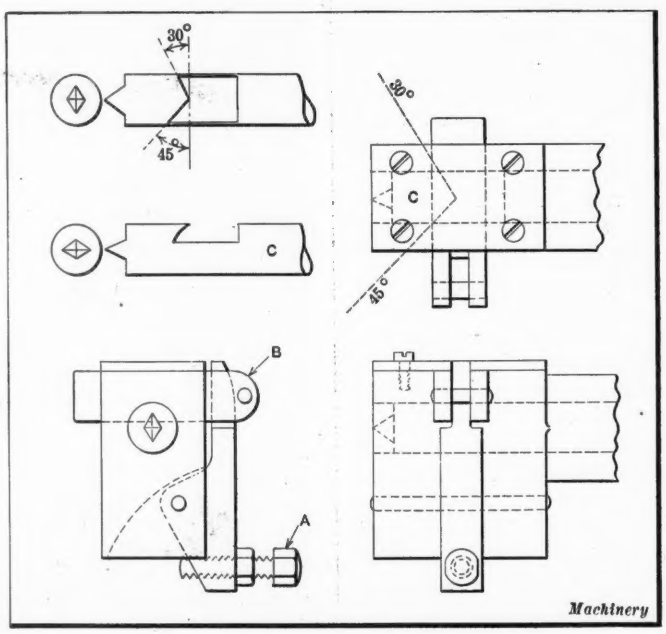
* * *

STOP AND CENTERING TOOL

BY ROBERT GALLAGHER[1]

The combination stop and centering tool here shown is used on a No. 2 Brown & Sharpe automatic screw machine. It is used as a stop when feeding out stock and also for centering a piece that has to be drilled. Where six tools have to be used in the turret, including the facing and centering tool, it is much more economical to use this tool than the old-style facing and centering tool, as no stock is wasted. It is more accurate in securing exact lengths than is the method of feeding stock to the centering and facing tool. On one order for 100,000 pieces, a shop saved $300 on material alone, besides increasing its production. This shop is now using this tool on all brass jobs over ½ inch in diameter.

To operate this tool, an extra lobe is provided on the front cross-slide cam which operates when the tool is advanced for



Stop and Centering Tool

the stock to feed out against it. The tool dwells in this position while the front slide advances and comes in contact with the adjusting screw of lever *A*; this draws out the cross-bar *B* which is notched, the notch having two angles of 30 and 45 degrees. The cross-bar is drawn out against the 30-degree angle, which, in turn, advances the centering tool *C*. When its work is finished, the cross-slide backs away and a spring in the shank draws back the centering tool.

* * *

Among the artificial limbs tested by the Verein Deutsche Ingenieure at its testing station in Charlottenburg is the magnet hand invented by Prof. Klingenberg. The attachment of this hand to the arm or shoulder ends in a cup which encloses an electromagnet. This cup has a ball bearing and can be clamped in any position. The electric circuit is closed or opened by the aid of the outer arm or the chin. With this hand, a man may do filing and planing, put metal sheets under a punch, and manipulate shears or pinchers. Tools not made of iron may be handled if they are provided with an iron ring or plate. The hand can also be provided with fingers and a thumb to be opened or closed separately.

[1] Address: Harrison, N. Y.

AUTOGENOUS WELDS OF BOILER PLATES[1,2]

METHOD OF MAKING WELDS AND THEIR AFTER-TREATMENT, ALSO TESTS TO BE APPLIED AND THE FIELD FOR AUTOGENOUS WELDS

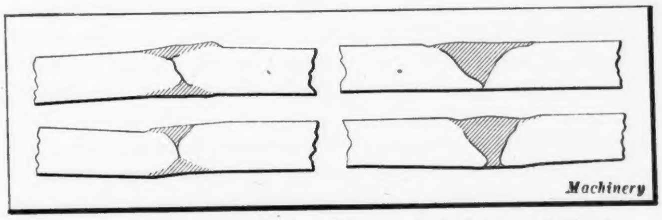


Fig. 1. Welds made with too Sharp an Angle between Surfaces

BECAUSE of the growing importance of autogenous welding, the Swiss Society of Steam Boiler Owners recently conducted a series of tests "to produce exact data on the actual status of the art and to assist in its development." But in these tests, as in all Swiss practice, autogenous gas and electric welding are treated separately, for gas welding alone is known as autogenous. In these tests the most frequent defects were found in the joining of the original metal to the added metal, or between successive layers of the added metal, where it was more nearly "pasted" than welded. The principal cause of these defects was that the edges to be welded were too close together.

The angle of the opening prepared for welding, whether chipped or burned out, should be at least 90 degrees, and the width of the bottom of the V should be at least 3/32 inch for sheets 1/2 inch thick. If the angle is too acute, the flame cannot penetrate to the bottom in an effective manner. It is pushed and frequently blown out so that only the upper edge is welded to the filling material, as shown in Fig. 1. On the other hand, if the slot is wide enough and open at the bottom, the flame reaches all the surface, and fuses the edges of the plate throughout their entire extent. Although the expenditure of time, metal and gas seems greater for a wide opening than for a narrow one, the reverse is true. Properly welded pieces are, without exception, made in widely opened slots, as shown in Fig. 2.

Whether it is better to weld from one side only or from both sides depends principally on the thickness of the sheet. When welding from one side, the space for the reception of the added metal is greater than if the welding is done from both sides, and it would seem as though the consumption of welding metal would be greater; in practice, however, this is the case only to a slight extent. When welding from both sides, it is of the greatest importance that the welding be finished at a single heat; this is only possible, when welding from one side, in the case of thin or moderately thick plates. When welding thick plates from both sides, the two sides should be welded and hammered simultaneously.

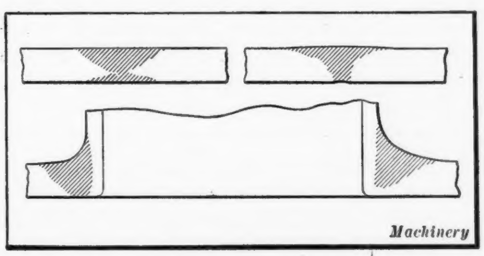


Fig. 2. Welds made with Wide Angle between Surfaces

Another cause of poor welding is insufficient preheating of the parts to be welded. This defect arises either from lack of experience or attention, for a welder who knows his trade should know the instant that the pieces of metal to be welded are in a condition to melt or flow together. Examples of this fault are shown in Fig. 3; at A is shown a piece of metal stuck on the plate, only the edges of which are welded.

Other grave faults, developed by the etch tests, are blowholes, deposits of oxide, soft (weak) structure, etc.; these defects also arise from lack of skill. There is also the development of oxides during the welding. Iron raised to a high temperature absorbs oxygen rapidly from the air. Since oxygen is used directly to make autogenous welds, the formation of oxides is much greater if the flame carries an excess of oxygen. It is necessary, then, to regulate the mixture of gases in the torch. On the other hand, if the flame has an excess of acetylene, the acetylene will carburize the liquid iron and transform it into steel. One must, therefore, regulate the blowpipe flame exactly right, which will be done when the core of the flame is white, very luminous and somewhat limited in size, but not too short. If the core is short and the flame tinged with violet, oxygen is in excess; and when it is extremely luminous, acetylene is in excess. When the flame is well regulated, the preheating of the oxygen tends to steady the flow, although trouble may arise from the condensation of water which forms in the tubes.

Burned metal results from too high a temperature. It is facilitated when the flame carries an excess of oxygen. An oxidation and partial decarburization of the iron is produced, for which the iron itself (by its combustion) furnishes part of the heat. The action of the cutting torch depends also on a greater consumption of oxygen than does the welding torch. In this respect, the distance from the core of the flame to the weld is of great importance. Oxides are eliminated by agitating the molten metal with the welding wire, which brings them to the surface. Powder is no longer used in welding mild steel to reduce the oxides; cast iron presents a different problem. The skilled use of the torch and the welding rod will avoid oxidation. If possible, the welding wire should never make actual contact with the flame, but both should be kept in motion and in such a way as to avoid each other.

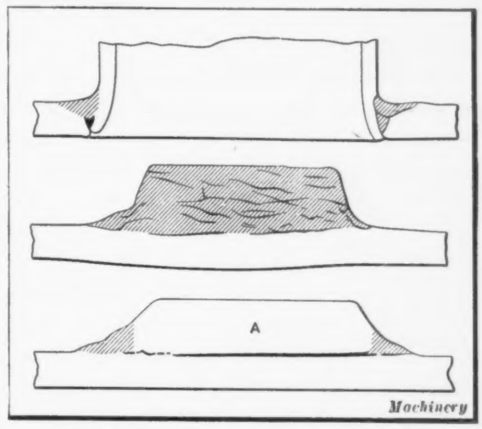


Fig. 3. Poor Welds caused by Insufficient Preheating

The test specimens that broke at the weld possessed on an average only 76 per cent of the strength and 39 per cent of the elongation of the unwelded pieces. The specimens that broke outside the weld had 87 per cent of the original tensile strength and 66 per cent of the elongation. Annealing may have contributed to this result, but as the average elongation fell to 53 per cent of the comparison plate, the conclusion is forced that the quality of the metal suffered. The influence of annealing was further demonstrated by tests by the Brinell process, the results of which, in general, parallel those of the tension tests. While the specimens of the unwelded plate gave a mean value of hardness $H = 115.6$, the mean for plates with autogenous welds fell to 102.8 when measured outside the weld, or 89 per cent of the hardness of the unwelded plate. When measured at the weld, the mean hardness was found to be 108.2, or 94 per cent of the hardness of the unwelded plate. The diminution of 11 per cent in hardness represents

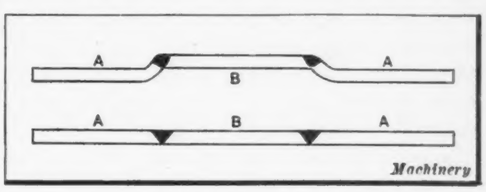


Fig. 4. Welding a Piece into a Plate

[1]Abstract of an article by E. Hohn printed in "The Locomotive" of October, 1916, and January, 1917.

[2]For other articles on autogenous welding previously published in MACHINERY, see "Welding 18-foot Tube Sheets for Sugar Evaporators" and "Aluminum Welding," August, 1916; "Strength of Oxy-acetylene Welds," June, 1916; "Metal Cutting with Oxy-acetylene Gas," April, 1916, and articles there referred to.

about what could be attributed to the annealing; and although the metal was somewhat harder at the weld than outside it, the difference was only 5 per cent. The softest of the autogenously welded plates had the greatest elongation—101 per cent of the unwelded plates; the hardest had the highest tensile strength—90 per cent. The electrically welded plate was harder than all the others, especially at the weld.

Impact Test

An important addition to the tensile tests is the impact bend test on notched bars. These tests were made on six bars, machined on the top and bottom edges, that were supported at their ends and struck with a ram weighing 116.85 pounds. The impact in every case was applied at the weld and in the longitudinal direction of the joint. The average work of deformation was 32 per cent of that of the unwelded bar and the angle of bending was 22 per cent. Thus the tenacity of the metal was much less than its tensile strength showed. It is worthy of note that the best plate, from the standpoint of the execution of the welds and for elongation and malleability, was the poorest when classed according to its resistance to impact. On the other hand, plates that yielded poor results in the tensile tests did very well under the impact test. It appears that as far as resistance to impact is concerned, some of the less homogeneous and more fibrous welds are superior to those that are of a more uniform structure.

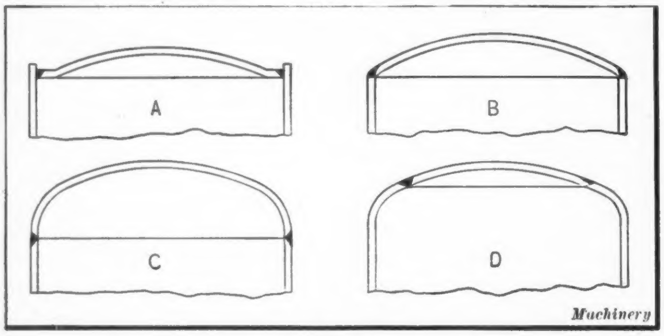


Fig. 5. Proper and Improper Methods of welding Drum Heads

Although they are not provided for in the official specifications for the acceptance of material, impact bend tests should become an important test method for those engaged in autogenous welding, both because the test yields information as to the nature of the weld itself, through the appearance of the fracture, and because, in tensile testing, a weld is recognized as good if the specimen breaks outside the weld. The impact test is the one best adapted to yield information in a very simple manner as to the effect of heat-treatment. Doctor Schmid, of Zurich, recommends this test to determine if steel has been forged at the blue heat; this test has been successful with him when tensile tests, ordinary bend tests, and even microscopic examinations have failed.

Hammering and Annealing

Several test plates were returned out of shape and some with displaced edges, showing that the welders lacked the skill necessary to align and fix the parts to be welded. The melted iron at the joints exerts a tension in cooling, and if the pieces to be welded are not fastened together solidly, their edges are displaced, even during the progress of the welding itself. On cooling, internal stresses cause the plate to buckle. Two firms that measured the effect of the contraction set up in welding have found that for plates 0.4724 inch thick the contraction was from 0.0197 to 0.1299 inch. It is possible during welding to counteract this contraction to some extent by hammering, and then later on a further diminution can be obtained by annealing. Hammering can also be done at the time of annealing. Hammering with small hammers while the metal is red-hot improves it, the same as rolling and forging improve structural iron. But if the hammering is done at a temperature lower than a red heat, there is danger of working the metal at the blue heat, which must always be avoided.

When welding a square piece *B* into the plate *A*, Fig. 4, the best plan is to raise the interior edges of *A*, and after welding, lay back the whole joint while the metal is hot by means of the hammer. By this process, the joint is strongly compressed and the internal stresses relieved; and at the same time the workman retains control of the form of the work.

By annealing after welding, a compensation of the residual internal stress is obtained and the annealing further improves the metal, giving it a finer grained structure. It is not enough to make a sound weld, but the metal must also be submitted to a heat-treatment or a simultaneous heat and mechanical treatment (hammering and annealing), which will give the best possible mechanical qualities and, above all, great toughness or resistance to impact. The annealing temperature for welded plates is between 700 and 800 degrees C. The exact temperature plays an important part; relatively small differences of from 40 to 60 degrees C. may have a considerable influence on the brittleness of the material. When it is necessary to anneal with the welding torch, it is best to give the preference to a short anneal at a high temperature.

Preparation of Materials for Welding

For the most satisfactory welds, the consumption of oxygen, and hence of gas, is most rapid, while the poorest welds are made with the least gas. Whoever tries to economize in gas risks making a poor weld; further, there is no control of the gas. It is well known that the gas should be pure and fresh to get a good weld; above all, it should contain neither sulphur nor phosphorus, for fear of making a weld either hot-short or cold-short. This is why illuminating gas should not be used by welders in place of acetylene; illuminating gas is not pure enough. Only the best pure iron should be used for the welding wire, as, for example, Swedish charcoal iron.

Conditions for a Good Weld

The conditions that are necessary to obtain good welds are: sufficient good, pure, dry, fresh gas; a torch that is correct as to both design and size; pure charcoal-iron wire as added metal; sufficient preparation, in the way of correct chipping or other working of the joints to be welded, both to secure correct angles, correct distance apart, and solid fastening; exact flame mixture; preheating of pieces to be welded; avoiding oxidation by properly managing both the torch and the welding wire; removing the oxide that forms in spite of all precaution; hammering after welding and annealing.

Field of Application

The true field for welds is on objects the joints of which must resist compression, as in furnace tubes, iron fireboxes, etc. The possibility of producing a thickening of the joints, which exists equally for the electric and the autogenous welding, should be considered an important advantage. In the present status of the process, it is recommended that in the construction of steam apparatus use should be made of autogenous welding only with the greatest prudence and that the work should be done by reliable firms and under the supervision of the inspection societies. Even then it is necessary to take account of the fact that, through the heating of the edges in welding and the cooling of the melted metal, there are set up in the iron that sort of tensions that produce accidents. Joints that must resist tension and bending stress through external forces or changes in temperature should not be welded unless it is possible to anneal the piece afterward.

A welded joint always carries something hidden and uncontrollable. It is not desirable to make welded joints where riveting can be done without difficulty. There remain plenty of places where for reasons of construction, for lack of room, or because great strength is not required, autogenous welding will find employment. For objects not under the legislation that applies to boilers, it is possible to go further and permit welds supporting fairly severe tensions; in this, much depends on the intelligence with which such work is carried out. When a head is welded to a drum, as shown at *A*, Fig. 5, it is in opposition to good practice; neither is the weld shown at *B* any better, for it is at the turn or at the edges that the bending strains are set up. Welds like *C* and *D* are recommended. To joint a tube to another or to a plate, the edges should always be relieved.

MILITARY INFLUENCE ON MOTOR TRUCK DESIGN[1]

WHILE American motor trucks have played an important part in the present war, it has not been necessary to make any radical changes in their design to meet military conditions. This has been due to the fact that, on the western front, the armies have been in practically the same positions for two years, so that the trucks have been used mostly on the first-class French roads; in the event of any fighting on American soil, though, much different conditions would be encountered. The trucks would be used on roads of all kinds, and even where there are no roads at all, and under widely varying climatic conditions. The use of motor trucks on the Mexican border has shown that many changes in design must, therefore, be made before the standard commercial truck will satisfactorily meet our military war needs. It is probable that most of the transport work will be done with two-wheel driven vehicles, for where road conditions will permit of its passage this type will haul material in the minimum time and at the minimum operating expense.

One of the first and most important points in connection with the design of a military truck is the absolute necessity for governors on the motors, not only to limit the maximum vehicle speed on high gear, but also to limit the maximum motor speed on any of the gears. This is an important consideration for soft-road operation, where, if a governor that limits only the maximum road speed is fitted, there is a great temptation to the driver to run for long periods on second or third gear in the transmission with the motor racing, a practice that will materially shorten the life of the motor. Governors must be thoroughly enclosed and sealed to prevent their being tampered with without the knowledge of those in authority, and, in order to obtain the best results, should be extremely sensitive, without "surging."

To obtain the best results over soft-road conditions, and without disconnection of governors, the average American commercial truck has insufficient high-gear ability and far too little low-gear ability successfully to pull its load through deep sand or mud or over extreme grades. For American military purposes, the low-gear tractive effort should at least be sufficient continuously to turn the rear wheels of the fully loaded truck on dry asphalt with the truck itself stationary. Using a coefficient of friction between the tires and a drp asphalt surface of 0.6 and a total rear end loaded weight of 7600 pounds for a 1½-ton truck loaded to capacity, the low-gear tractive effort necessary to meet these requirements becomes 4560 pounds. Commercial-truck practice now gives far lower figures. The low-gear tractive effort of what is considered a powerful 1½-ton commercial service truck is only 2600 pounds. To carry safely the low-gear torque required to give 4560 pounds tractive effort, the driving members throughout, from the gear train in the transmission clear back to the rear tires, must be made heavier and stronger, which, of course, will result in an increase in chassis weight.

The heat-dissipating ability of the average radiator was found inadequate, a serious matter at any time and more serious in a country where water is scarce. With the thermometer standing at from 110 to 120 degrees in the shade and the truck using maximum motor power on low gear for long stretches, extraordinary motor-cooling ability is required. Probably an increase of 50 per cent over average commercial practice will not be excessive, and a desirable provision will be a simple means for reducing the radiating area for efficient use in the cooler sections of this country. The radiator mounting should be such as to minimize any strains, in the radiator proper, that are set up as a result of excessive chassis-frame deflection, and the radiator should have large water passages, resist breaking under distortion, and be readily repairable in the field.

Four-speed transmission is more desirable than three-speed for military purposes. If the low-speed reduction ratio in a three-speed transmission is made great enough to give proper low-gear tractive effort, the steps between speeds become so great as to interfere with easy gear shifting. Furthermore, the four-speed gear-box has the very important advantage over a three-speed box, for soft-road service, of always having a gear ratio more nearly adapted to any particular road requirement than can be obtained in a three-speed box. It is probable that the gear ratios in a four-speed box for military trucks will be so arranged that second speed will be used for normal starting on hard-road surfaces, and that the first speed, or low gear, will have a greater reduction ratio than anything that has been built to date. This extra low gear with an extremely high reduction ratio will be used for starting or running in sand or mud or for climbing steep or soft grades.

The control elements should be standardized. Where men must drive different makes of trucks, they should be able to do so with facility, and much time will be saved and better average operation assured if the same motion of the driver's right or left hand or foot produces the same result irrespective of the make of the truck.

Trucks for army service ought to have a specified gage in order that each size or make does not have to break down a new track in the roadway. If all sizes of trucks could be made to the present standard road gage of 56½ inches, such standardization would be of the utmost value from a commercial as well as a military standpoint, as it would facilitate the operation of all trucks over soft country roads.

The best results will be obtained from some form of fully enclosed final drive, which should be so thoroughly enclosed as to retain lubricant and prevent the deposit of fine dust or grit on any of the working parts. Whatever form is used, whether worm, internal gear or double reduction, it should be capable of efficiently and continuously transmitting the maximum low-gear torque of the vehicle without overheating, and give at least a 10-inch road clearance with 36-inch tires.

The development of a braking system suitable for a military truck presents severe problems in regard to cooling. The brakes used on the commercial trucks of today are not well enough cooled to stand up long under some military conditions, as, for instance, handling the fully loaded truck on a three-mile descent on a hard-road surface with grades running up to 25 per cent and averaging 7 per cent. The brakes have sufficient power to hold the truck under such conditions, but will heat up so that the linings char slightly and wear rapidly. Water cooling is undesirable, so it is probable that some type of metal-to-metal brake will be necessary, which, while not as smooth in action as and noisier than the conventional brake and faced with brake lining, will give greater durability under continuous application.

It is essential that thorough means be provided to keep dust and grit out of all working parts. Troubles from dust are more liable to result on trucks in military service than on those in commercial service, due to running in "fleets," or trains, over country roads. The question of road clearance is also of great importance. Not only should a minimum clearance of 10 inches at the center of both the front and rear axles be maintained, but the clearances under the steering-knuckle levers and the steering cross-tube ends must be as great as possible. Furthermore, unusually high road clearance is desirable under the chassis, midway between axles, to prevent contact with the ground when the truck is driven over a bank into a river bed or over a ridge.

To take care of excessive frame distortion, which is unavoidable when operating over rough or soft roads, the radiator, motor, and transmission should be carried on three-point suspensions and with clearances sufficient to obviate any possibility of their being themselves distorted. Provision should be made to protect the steering column from any binding from the same cause, and all connections between the rear axle and frame should be arranged to permit the maximum horizontal misalignment between the two without overstressing or breaking any of the connecting members. The gasoline tank mounting should also be carefully arranged to protect the tank from twisting strains.

[1]Abstract of a paper read by H. D. Church before the Cleveland Engineering Society.

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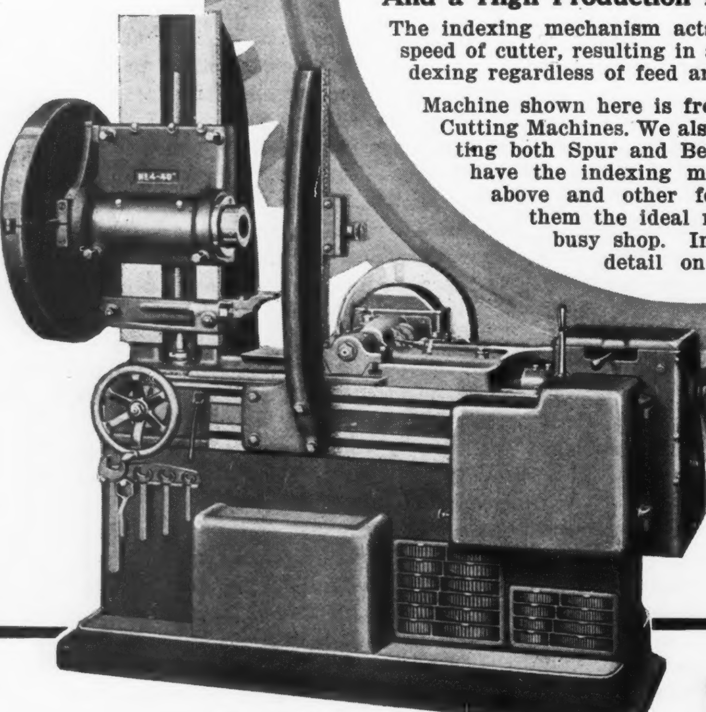

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NEED OF ENGINEERS IN PRESENT WAR

According to Capt. Gustave P. Capart of the general staff of General Pétain, who is at present in this country as a member of the French scientific commission, the old military lines of organization have practically been replaced by a specialized industrial organization whose business is war. The offensive military operations are planned on an engineering basis and the fighting is done, in many branches of the service, by engineering methods. He says that the engineers who go to France as military men in their specialized branches will also be pioneers of American industry in times of peace and will prepare the ground for the economic war that is expected to follow when the military battles are over.

Military operations may be thought of as being conducted in four zones: First, the firing line; second, the military zones immediately surrounding the firing line; third, the avenues and channels of communication between the military zone and what may be called the world-wide zones of supplies to that military zone; and, fourth, the zones of supplies themselves, which include the countries at war and the countries supplying food, machinery and materials to the countries at war. On the firing line, troops in contact with the enemy, engineers are involved in the strictly military operations; mining engineers are planning the executing of trench work, earth work, concrete work, and so on; while other engineers maintain what the French so interestingly explain as a "liason"—the nerves of communication between the various sectors of the armies.

In the military zone, which is entirely in the control of the military and potentially and actually threatened by the enemy, engineers are busy building and maintaining roads, constructing, maintaining and operating railroads, building, rebuilding and operating automobiles, constructing narrow-gage railroads, cableways, telpherage systems, etc. Cableways and telpherage systems have given very valuable service at the front; 600 mules were turned to other service by the installation of one telpherage system. In this zone electrical engineers are at work building and operating lighting and power plants, erecting and maintaining distributing lines, handling the network of telephone and wireless centers of communication. Waterworks and water-supply engineers, sanitary engineers, engineering construction gangs erecting shelters and raising camps and cantonments and repair shops for aeroplanes, automobiles, artillery, small arms, are all necessary in the military zone.

* * *

MISUSE OF WRENCHES IN TIGHTENING COVER BOLTS

A large number of vessels used for subjecting materials to high temperatures and pressures have doors or stock openings of relatively large size that must be frequently opened and closed, such as vulcanizers, digesters, impregnating tanks, etc. As a rule, these doors or covers are furnished with a flange that matches a somewhat similar flange on the shell of the vessel proper and are fastened to the vessels by a large number of bolts. Recently, the cover of one such vessel, eight feet in diameter, failed through the breaking of its reinforced flange, which permitted the cover to blow off with explosive violence, although the pressure inside the vessel did not, probably, much exceed thirty pounds per square inch. The flange, though, was probably damaged when the vessel was being closed preparatory to cooking. After centering the cover over the vessel and making sure that the jointing or packing ring was clean and in place and that the bolt slots were opposite those on the vessel, the cover was lowered into place and the bolts swung up into the slots. Then one man started to run down the nuts of the thirty-two $1\frac{1}{8}$-inch bolts, by hand, while another started right behind him and tightened the nuts with a wrench 54 inches long. Any slight irregularity or projection of the packing caused the cover to cock up to one side when the first few nuts were tightened; then, when the man with the wrench reached the point opposite to that at which he started, an enormous strain was produced in the effort to get a tight joint.

It is as necessary to follow the proper method of fastening such a cover as it is to secure a safe design. The first requisite is to see that only such wrenches are available as will not permit an excessive strain to be put on the bolts. Socket or end wrenches of the correct length and so formed that they do not adapt themselves to lengthening with a piece of pipe are satisfactory, and at least two should be provided. Two men should run down the nuts, by hand, to a bearing, beginning at opposite sides of the cover and working in the same direction so that each will end where the other began. Then each should take a wrench and set up slightly, about half tight, on one or two bolts at points opposite each other. They should then tighten two or three bolts each at points midway between those first set up. Then all the bolts in opposite quadrants, first one pair and then the other, should be tightened. When all the bolts have been set up, the process should be repeated, the nuts being set as tightly as is felt will be required to get a tight job, and no more. If the cover joint leaks when pressure is applied, the reason should be found and the remedy applied with pressure off the vessel; in no case should the nuts be set up in an endeavor to secure tightness while the pressure exists.

Leakage after reasonable tightening of the bolts usually indicates defective packing or the presence of some foreign matter between the surfaces in contact. Excessive bolt strain may effect an apparent cure by embedding the foreign matter in the yielding packing material, but it can only do so by setting up local stresses in the flanges, which, if repeated often enough, always lead to failure by cracking. The working stress is all that the material should be called upon to carry.

Many of these vessels have reinforcing, or joint, rings of cast iron; this material should be carefully watched. It is much less trustworthy than cast steel, which replaces it in the best designs, and is much more likely to fail by cracking if abused by the operatives. Master mechanics or shop superintendents should look over the flanges of the vessels from time to time. Any cracks, no matter how small, are suspicious.—*The Locomotive.*

* * *

ALFRED HERBERT KNIGHTED

As MACHINERY went to press the following cablegram was received:

Honors conferred: Alfred Herbert, Knight Commander, Order of British Empire; Ernest Parkinson, Parkinson & Sons, Officer of same Order; Percy John Pybus, Phoenix Dynamo Co., Commander of same Order.

PERSONALS

M. V. Terry has been appointed chief engineer of the Champion Ignition Co., Flint, Mich., manufacturer of spark plugs.

Harvey B. Wheeler has been appointed supervising engineer in the New York territory by the National X-Ray Reflector Co. of Chicago.

Oliver J. Abell, 565 Washington Boulevard, Chicago, Ill., has been elected a director of the American High Speed Chain Co., Indianapolis, Ind.

David Van Alstyne has been appointed assistant vice-president of the American Locomotive Co., 30 Church St., New York City, in charge of manufacture.

J. Gustaf V. Lang has been appointed purchasing agent for the A. Bol. Stockholms Järnmanufaktur, Stockholm, Sweden, with headquarters at 8 W. 40th St., New York City.

P. M. Kling, who has been connected with the Laconia Car Co., Laconia, N. H., for thirty-four years as consulting engineer, has resigned in order to take a well-earned rest.

C. S. Vought, assistant general manager of sales of the American Steel Export Co., Woolworth Bldg., New York City, sailed for France August 7, to attend to business for the company. Mr. Vought will be gone about sixty days.

Robert B. Luchars, son of Alexander Luchars, and secretary of the Industrial Press, was appointed second lieutenant, Second Battery, Field Artillery section, Officers' Reserve Corps, at Officers' Reserve Training Camp, Fort Myer, Va., August 11.

J. W. Jowett, formerly general sales manager of the Ingersoll-Rand Co., 11 Broadway, New York City, was elected vice-president at a recent meeting of the board of directors. L. D. Albin, formerly assistant general sales manager, was appointed general sales manager.

H. A. Richmond has been elected managing director and treasurer of the General Abrasive Co. of Niagara Falls, N. Y., and has relinquished his connection with the American Emery Wheel Works, Providence, R. I., of which he has been president and technical expert for the past twenty years.

Edwin T. Jackman, of E. S. Jackman & Co., Chicago, Cleveland and Pittsburg, agents for the Firth-Sterling Steel Co., McKeesport, Pa., has received an appointment as first lieutenant in the ordnance section of the Officers' Reserve Corps, and is now on active duty.

Henry M. Wood has resigned from the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, to become associated with Axel Malm in the Malm & Wood Machine Co., Dayton, Ohio. The new concern will manufacture rotary punch presses and dies. Mr. Malm is president and mechanical engineer and Mr. Wood is vice-president and general manager.

J. T. Plummer, district manager for the Haynes Stellite Co., with offices in Cleveland, has been transferred to the executive offices of the company at Kokomo, Ind., and has been assigned the state of Indiana and the southwestern section of Ohio. Mr. Plummer was formerly western representative for the Driggs-Seabury Ordnance Corporation and is well known among the automobile and tractor parts manufacturers.

Walter R. Morris has been appointed assistant traffic manager of the American Steel Export Co., with headquarters in the Woolworth Building, New York City. Mr. Morris was previously assistant traffic manager of the American-Hawaiian Steamship Co., New York City, and had been associated for many years with the Southern Pacific Co., and the Pacific Mail Co., in their traffic departments in San Francisco and New York City.

M. J. McCormick, who was previously connected with the Canadian Fairbanks Morse Co., Montreal, Canada, as manager of the machine tool department, is now associated with the McCormick Machinery Co., 14 St. John St., Montreal Canada. This company manufactures machine tools and supplies, making a specialty of hobs and chasers. It will also undertake to find buyers for any surplus equipment that its customers wish to dispose of.

Alfred L. Holmes and C. M. Goldman have joined the sales organization of the Pangborn Corporation, Hagerstown, Md. Mr. Holmes will be district sales agent at Cleveland and Mr. Goldman will be district sales agent at Philadelphia. Both men are well acquainted throughout the foundry and metal-working trades. Mr. Holmes was formerly with the Pangborn Corporation in the same capacity for six years, and Mr. Goldman has been representing the Obermayer Co., in the Philadelphia territory for several years.

Stanley W. Hull, Cleveland, Ohio, is the head of a new mechanical drafting service company for inventors and manufacturers known as S. W. Hull & Co. During the past ten years, Mr. Hull has been employed in the engineering departments of the General Electric Co., Westinghouse, Church, Kerr & Co., and the Brown Hoisting Machinery Co. He has paid particular attention to limit systems for the production of interchangeable parts, and will specialize in the design of mechanical and electrical devices.

OBITUARIES

J. C. Small, former manager of the Aurora Tool Works, Aurora, Ind., manufacturer of upright drills, died July 24, aged seventy-three years. Mr. Small was for several years identified with the machine tool business and was very well known to the trade.

Arnould C. Butters, sales manager of the Industrial Press, died of pneumonia at the Polyclinic Hospital, New York City, after a brief illness, on Saturday, August 25, at the age of fifty-two. Mr. Butters, whose name is familiar to thousands of MACHINERY'S readers, was for nine years in charge of the book and subscription department of the business, and filled the position with signal ability. Quiet and undemonstrative, he was, nevertheless, remarkably efficient and possessed an extraordinary capacity for details. He liked to call himself "a detail man," but he was never lost in details—always he was master of them, and his records of work done and results obtained were models of comprehensive, intelligible business statistics, accurate, reliable records to light the way for future campaigns. His attitude toward facts—toward truth—was invariably that of the expert workman, who keeps to the line and aims for absolute accuracy.

Mr. Butters will be greatly missed by his associates, and by those whose labors he directed, to whom he was always kind and considerate. The loss of this well-trained business man will be felt by the company to which he had rendered for many years loyal, enthusiastic and highly efficient service.

COMING EVENTS

September 10-15.—Annual convention of the National Safety Council, New York City; Hotel Astor. headquarters. Marcus A. Dow, president, Grand Central Station, New York City.

September 10-15.—Exposition of safety appliances at the Grand Central Palace, New York City, under the auspices of the American Museum of Safety, 18 W. 24th St., New York City. Arthur H. Young, director.

September 25-28.—Twenty-second meeting of the American Foundrymen's Association, Boston, Mass.; Copley-Plaza Hotel, headquarters. The registration booth will be in the Mechanics' Bldg., where the exhibition of foundry and machine shop equipment and supplies will be held. A. O. Backert, secretary-treasurer, 12th and Chestnut Sts., Cleveland, Ohio.

September 27.—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137, Sibley Block, 328 Main St., E., Rochester, N. Y. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester.

September 27-29.—Informal congress and reunion of American and Canadian engineers and architects of Norwegian birth or descent in Chicago at Chicago Norske Klub, 2346 N. Kedzie Blvd., Logan Square, Chicago, Ill.

October 9-11.—Annual congress of Purchasing Agents at Pittsburg, Pa. James H. Robison, chairman, 600 Westinghouse Bldg., Pittsburg, Pa.

SOCIETIES, SCHOOLS AND COLLEGES

Society for Electrical Development, 29 W. 39th St., New York City. Booklet containing a comprehensive review of the activities of the society.

Northwestern University, Chicago, Ill. Bulletin containing the annual catalogue for 1916-1917, giving complete information relating to the university, its faculty, courses, etc.

Ohio State University, Columbus, Ohio. Bulletin 16, containing the following papers presented before the Congress of Human Engineering, held last October at the Ohio State University: "Ideals and requirements and Training for the Engineering Profession;" "The Timeliness of the Congress of Human Engineering;" "Human Engineering in Steel Mills;" "The Hours of Labor or Getting on in the World;" "Social and Industrial Democracy in the Colorado Fuel & Iron Co;" "The Handling of Men;" "The Human Factor in Industry;" "Human Engineering and Welfare Work:" "Human Engineering from the Viewpoint of a Wage Earner;" "The New Emphasis on the Human Factor in Industry;" "The Human Side of the Worker;" "The Engineering of Men;" "New Ideals in Human Engineering;" "Scientific Management and Progress."

NEW BOOKS AND PAMPHLETS

Modern Machine Shop Construction, Equipment and Management. By Oscar E. Perrigo. 384 pages, 6¼ by 9¼ inches; 219 illustrations. Published by the Norman W. Henley Publishing Co., New York City. Price, $5.

Books on machine shop construction and equipment are few, this work first published in 1905 being one of the chief examples. The second edition contains four new chapters of especial use to managers, accountants and shop men. The additional matter is on increasing the efficiency of machines and men, the relation of the overhead burden to the flat cost, and manufacturing cost systems.

United States Artillery Ammunition. By Ethan Viall. 98 pages, 9 by 12 inches; 171 illustrations. Published by McGraw-Hill Book Co. Inc., New York City.

This book consists of reprints of articles on the manufacture of munitions published from time to time in the "American Machinist." Readers of that journal are familiar with the series of articles on munition manufacture which have appeared in it during the past year. The book contains chapters on 3-inch common shrapnel, 3-inch high-explosive shells, 3-inch naval shells, 3.8- to 6-inch shrapnel high-explosive shells, 6-inch naval shells, and 3- to 6-inch cartridge cases.

NEW CATALOGUES AND CIRCULARS

Himoff Machine Co., 50 Church St., New York City. Circular of the "Hercules" 12-inch screw-cutting engine lathe.

Silver Mfg. Co., Salem, Ohio. Circular of Silver's 25-inch back-geared upright drilling machine with six positive geared feeds.

Independent Pneumatic Tool Co., Chicago, Ill. Circular Z describing in detail this company's line of pneumatic tools and electric drills.

Metalwood Mfg. Co., Detroit, Mich. Folder B-54, giving specifications for the Metalwood multiple-broach hydro-pneumatic broaching presses.

Challenge Machine Co. Inc., Philadelphia, Pa. Catalogue of "Challenge" emery wheel grinders, polishing machines and emery wheel dressers.

General Electric Co. (Fort Wayne Department), Fort Wayne, Ind. Circular 62557 descriptive of battery-charging equipment for lead or Edison batteries.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletin 1042 descriptive of E. C. & M. automatic compensators for alternating-current squirrel-cage motors.

Himoff Machine Co., 50 Church St., New York City. Circular descriptive of the "Hercules" 8- and 24-inch gear-hobbing machines, which have just been placed on the market.

Victor Tool Co. Inc., Waynesboro, Pa. Circular of the Sheuman floating reamer-holder for use on automatic screw machines, turret lathes and horizontal and vertical boring mills.

T. A. Willson & Co. Inc., 3rd and Washington Sts., Reading, Pa. Circular of Willson goggles for military wear, showing the different styles adapted for use in the army and navy.

Slocum, Avram & Slocum Laboratories, Inc., 531-537 W. 21st St., New York City. Folders descriptive of an improved type of sine bar and toolmakers' and machinists' indicating square.

J. H. Williams & Co., 61 Richards St., Brooklyn, N. Y. Catalogue of drop-forged tools, printed in Russian for the convenience of customers in Russia and those who are interested in trade with that country.

A. E. Russ Forged Drill Co., Cleveland, Ohio. Price list of Russ taper and straight shank forged twist drills. The drills are forged complete from bars of round steel, and are sold under the trade name of "Drill-Far."

Gisholt Machine Co., 1209 E. Washington Ave., Madison, Wis. Bulletin entitled "Gisholt Machines and Their Work," containing illustrations of the Gisholt machines at work and giving the time for producing the parts shown.

Boston Gear Works, Norfolk Downs, Quincy, Mass. Circular showing some of the types and styles of gears carried in stock by the company. Price list of gears containing changes of prices that went into effect July 1.

Standard Pulley Co., Cincinnati, Ohio. Pamphlet descriptive of the Standard countershaft clutch, Baechle patent, which grips 100 per cent of the surface of the clutch ring. The pamphlet contains illustrations showing the action of the clutch.

Sebastian Lathe Co., Cincinnati, Ohio. Circular illustrating and describing Sebastian 13-, 14,- and 15-inch geared-head quick-change-gear lathes, showing headstock gearing and giving a brief description of the construction, together with specifications.

Link-Belt Co., Chicago, Ill. Book 326, descriptive of Link-Belt "TT" roller chains for tractors and trucks, made to withstand the most severe service and the most difficult conditions under which these machines are called upon to operate.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Loose-leaf sheets for Cutler-Hammer catalogue giving list prices and dimensions of motor starters, speed regulators, controllers, self-starters, starting switches, and rheostats, together with other electrical apparatus.

Detroit Belt Lacer Co., Hubbard Ave. and A St., Detroit, Mich. Circular and price list of "Bull Dog" belt lacers and closing machines. It is claimed that machine-closed wire belt lacing is stronger than hand-laced belting and quicker to apply.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletin containing a reprint of a paper entitled "An Automatic Starter for Induction Motors," presented by H. F. Stratton before the Association of Iron and Steel Electrical Engineers at Chicago, May 26.

American Steel Export Co., Woolworth Bldg., New York City. Booklet entitled "Tin Plate," giving a brief history of tin plate manufacture, a description of the process of manufacture, and general information relating to tin plate of value to buyers.

Ingersoll-Rand Co., 11 Broadway, New York City. Bulletin 8213 on "Little David" pneumatic chipping, calking and scaling hammers. Bulletin 8006 on "Imperial" motor hoists and stationary motors. Bulletin 9102 on air receivers, pressure tanks and moisture traps for compressed air.

Triumph Machine Tool Co., 920 Citizens Bldg., Cleveland, Ohio. Bulletin 101 on "Triumph" heavy-duty radial drilling machines, motor driven, the motor being mounted on the radial arm, thus avoiding transmitting the driving power through long splined shafts and multiple bevel gears.

Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. Bulletin of hoisting machinery for industrial plants. The bulletin illustrates and lists floor-operated monorail hoists; floor-operated double rail hoists, hoisting units for jib cranes, derricks, elevators and stack hoists; and motor winches and back-geared motors with high gear ratios.

Buffalo Dental Mfg. Co., Buffalo, N. Y. Catalogue B of laboratory and workshop appliances, including gas furnaces, brazing stands, blowpipes, gasoline gas generators, foot blowers, power blowers, bunsen burners, soldering blocks, melting arrangements, anvils, pickle pans, soldering fluxes, files etc.

Link-Belt Co., Chicago, Ill. Book 361 entitled "Some Facts about Roller Drives," written by A. Lee Henson of the Smith Motor Truck Corporation, Chicago. The booklet tells why the Smith Motor Truck Corporation adopted the chain drive for its "Form-a-Trucks" which are subjected to the most severe tests of service.

Brown Instrument Co., Philadelphia, Pa. Bulletin illustrating furnace and pyrometer control equipment used by Seaman-Sleeth Co., Pittsburg, Pa., for annealing semi-steel rolls. The rolls require to be kept at a temperature of 1800 degrees F., for forty-eight hours, the total time of annealing requiring six days.

Skinner Chuck Co., New Britain, Conn. Catalogue and price list 30 of Skinner chucks, containing 71 pages 4 by 7¼ inches. Dimensions and prices are given for independent chucks, faceplate jaws, universal and combination geared screw chucks, geared scroll combination chucks, faceplate castings, planer chucks, drill press vises, drill chucks, center arbors for drill chucks, etc.

Webster & Perks Tool Co., Springfield, Ohio. Loose-leaf catalogue illustrating and describing in detail the Webster & Perks complete line of grinding and polishing machinery and accessories, comprising plain and ring-oiling bearing, ball bearing, and direct-connected electrically-driven types. The company has in stock for prompt shipment, many of the different sizes and styles of these machines.

Charles A. Schieren Co., 30-38 Ferry St., New York City. Booklet entitled "Belt Buyers' Guide" containing useful data, information and directions for all users of belts. It treats of the belting problem, Schieren service, economy of good leather belts, methods of lacing belts, importance of properly aligned pulleys, how to make quick repairs, cementing belts, etc. Convenient rules are given for estimating the sizes of pulleys to secure any desired velocity ratio.

Columbian Hardware Co., Cleveland, Ohio. Poster entitled "American Fundamentals" carrying four great declarations of principles, the first being from the Declaration of Independence, 1776; the second from President Washington's farewell address, 1796; the third from President Lincoln's Gettysburg address, 1863; and the fourth from President Wilson's war message to Congress, 1917. Copies will be sent free for hanging in shops, mills and factories.

American Steel Export Co., Woolworth Bldg., New York City. English catalogue of iron and steel products for foreign distribution. Spanish, French, Portuguese, Italian and Russian editions are to be published shortly. The catalogue contains useful information, such as weights and measures in English and metric tables and data on pig iron, billets, blooms, slabs and sheet bars, plates and shapes, tool steel, merchant bars, wire products, pipe, tubing, railway supplies, etc. The object of the catalogue is to inform foreign buyers concerning American weights, measures, etc.

S K F Ball Bearing Co., Hartford, Conn. Circular containing photographs and statements from the following men, giving their opinion concerning the use of S K F ball bearings on the machines of their manufacture: L. H. Colburn, Colburn Machine Tool Co.; C. M. Conradson, Phoenix Mfg. Co.; F. E. Gardner, vice-president of the Gardner Machine Co.; James N. Heald, general manager of the Heald Machine Co.; A. J. Langelier, president of the Langelier Mfg. Co.; Ralph R. Lapointe, Lapointe Machine Tool Co.; E. W. Miller, chief engineer, Fellows Gear Shaper Co.; A. H. Moore, manager of the Bath Grinder Co.; James C. Potter, of Potter & Johnston.

Carborundum Co. Niagara Falls, N. Y. Catalogue 6, 224 pages, 6½ by 9 inches, devoted to carborundum and aloxite wheels for all classes of grinding. The catalogue treats of the characteristics and uses of carborundum and aloxite; manufacture of carborundum and aloxite wheels; characteristics and testing of grinding wheels; safeguarding and mounting of grinding wheels; rules for calculating surface and peripheral speeds; shapes of wheel edges; universal grinding; cutter and reamer grinding; plain cylindrical grinding; internal grinding; and grinding on horizontal surface grinders. The book is illustrated with color plates and other high-grade engravings.

Peter A. Frasse & Co., Inc., 417 Canal St., New York City. Catalogue of Frasse-electric and open-hearth steels, 98 pages, 4¼ by 7 inches, bound in cloth. The catalogue contains a complete description of the various grades and finishes of Frasse-electric tool and alloy construction steels. Numerous tables are included which should be of assistance to manufacturers whose products call for the various grades of steel. These tables include weights of bar steel per foot, decimal equivalents, equivalent temperatures, comparative table of gages in common use, metric conversion tables, etc. This company celebrated its one hundredth anniversary in business last year, and since its inception has always been identified with the steel industry in all its branches.

TRADE NOTES

Axelson Machine Co., has removed its office and plant to Boyle Ave. and Randolph St., Los Angeles, Cal.

Atlas Ball Co., Glenwood Ave. at 4th St., Philadelphia, Pa., has changed its name to Atlas Steel Ball Co.

National Tube Co., Pittsburg, Pa., has sold its Kewanee, Ill., plant and fittings business to the Walworth Mfg. Co.

J. C. Barrett Co., Hartford, Conn., has moved to 516 Asylum St., where better facilities have been provided for making wood and metal patterns.

American Steel Export Co., Woolworth Bldg., New York City, has appointed Woodburn's Ltd., Montreal, Canada, as its exclusive agent for Ontario and Quebec.

Cisco Machine Tool Co., Cincinnati, Ohio, is adding a building 30 by 120 feet to the present plant, and will place a 24-inch lathe on the market early in September.

Sterling Products Co. Inc., 547 Washington Blvd., Chicago, Ill., distributor of high-speed drills and hacksaw blades, has opened a St. Louis office at 938 Syndicate Trust Bldg., with R. O. McGraw in charge.

Victor Tool Co., Waynesboro, Pa., is erecting a new plant near the old location. The new structure is of brick, one story high, about 60 by 164 feet. The company will continue to manufacture its line of collapsing taps and other tools.

Pangborn Corporation, Hagerstown, Md., has purchased and taken over the sandblast department of the Curtis Pneumatic Machinery Co., St. Louis, Mo. The Pangborn Corporation will carry a complete stock and is prepared to give prompt service.

Ing. Ercole Vaghi, Corso Porta Nuova, 34, Milan, Italy, dealer in machine tools, requests American manufacturers of machine tools and small tools to send their latest catalogues and price lists. It is especially requested that the catalogues, if possible, be sent in triplicate.

Framingham Machine Works, Framingham, Mass., announce that their plant has been re-equipped with machinery and appliances for the production of gray-iron castings and the galvanizing of metal goods. Hereafter the company will be known as the Framingham Foundries.

Graham Bros. Stockholm, Sweden, manufacturers and dealers in various classes of machinery, announce that on June 1 the name of the company was changed to Graham Bros. Aktiebolag. The firm remains under its past management, its directors being P. S. Graham, K. G. Magnusson, and C. G. Rising.

Haynes Stellite Co., Kokomo, Ind., has discontinued its Cleveland office. C. G. Tarkington, district manager at Pittsburg, has been assigned the Cleveland territory and the eastern section of Ohio, and E. R. Smith, district manager at Detroit, has been assigned the northwestern section of Ohio, west of Cleveland.

Anderson Die Machine Co., Bridgeport, Conn., has moved its factory from 590 Water St. to more commodious quarters on Iranistan Ave., near Admiral St. The additional floor space and new equipment to be provided will enable the company to give better service than was possible in the limited quarters just vacated.

Falls Rivet Co., Kent, Ohio, has taken over the plant and business of the Kent Machine Co. In the reorganization of the business the following officers were elected: M. G. Garrison, president; W. S. Kent, vice-president; Roy H. Smith, treasurer, and Myles E. Ewing, secretary. The business will be operated separately under the name of the Kent Machine Co.

A. Bol. Stockholms Jarnmanufaktur, Stockholm, Sweden, dealers in machinery, tools, and hardware, have opened an office in New York City to enable them to keep in closer touch with the manufacturers in this country. J. Gustaf V. Lang has charge of the New York office, 8 W. 40th St., and acts as purchasing agent. He will be glad to hear from manufacturers and receive catalogues and quotations.

Charles A. Schieren Co., 30-38 Ferry St., New York City, has just completed an addition to its tannery at Bristol, Tenn. Equipment is being installed for the manufacture of the Schieren brands of belts, namely, "Duxbak" (waterproof), "Bull's Head," "Royal Extra," "CasCo," etc., most of which will be shipped to southern plants. The full capacity of the plant will be 50,000 feet of belting daily.

American Telegraphone Co., Springfield, Mass., has purchased the plant of the Rockford Watch Co., at Rockford, Ill., and will use the plant and equipment for the manufacture of telegraphones. The telegraphone is a form of the phonograph that uses a magnetized wire for the record instead of a wax cylinder. It was invented by Prof. Poulson, and a large sum has been expended in perfecting the mechanism of the original machine.

Russell, Holbrook & Henderson, Inc., 30 Church St., New York City, successor to the business in machine tools, special and automatic machinery of Lewis Russell, has been incorporated with a capitalization of $25,000. The business will be continued along the same lines as heretofore, with enlarged facilities. The officers are Lewis Russell, president; C. H. Holbrook, vice-president; and Lucien G. Henderson, secretary and treasurer.

Gisholt Machine Co., 1209 E. Washington Ave., Madison, Wis., owns the controlling interest in the Northwestern Ordnance Co., of Madison, but its connection will in no way affect the product or production of the Gisholt Machine Co. The two organizations are entirely independent. The Gisholt Machine Co.'s organization is in first-class shape to produce machine tools and equipment that will be required to meet the nation's military and industrial needs.

Heald Machine Co., 20 New Bond St., Worcester, Mass., has opened a branch office in the Commonwealth Building, Philadelphia, Pa., for the purpose of giving better service to its customers in that section. S. M. Hershey, formerly connected with the Hyatt Roller Bearing Co., of Newark, and the Norton Co., of Worcester, will be in charge. The office will serve the trade in Pennsylvania as far west as Altoona and in New Jersey as far north as Trenton.

Parker Mfg. Co., Detroit, Mich., manufacturer of drill chucks and arbors, elected the following directors at a recent meeting of the stock-holders: Gorham C. Parker, David J. Rice, Howard K. Chambers, Charles D. Bennett, and Kenneth P. Albridge. The officers of the company are Gorham C. Parker, president and treasurer; David J. Rice, vice-president; and Howard K. Chambers, secretary. The company was incorporated in July with a capitalization of $75,000.

Cincinnati Electrical Tool Co., Cincinnati, Ohio, has moved into its new quarters at 1501-1505 Freeman Ave., corner of Flint St., where increased facilities have been provided for manufacturing the line of portable electrical drills and grinders. The new quarters afford 32,000 square feet of working space and give light on four sides. Removal to larger quarters was made necessary on account of the greatly increased demand for "Cincinnati" electrical drills and grinders.

Link-Belt Co., Chicago, Ill., announces that it is now again in a position to furnish Link-Belt monorail electric hoists for quick shipment. The manufacturing of electric hoists was stopped during the past year because of unprecedented business conditions and overcrowding in the company's shops. These machines are made in the Philadelphia plant where a large additional building is rapidly nearing completion and where the present manufacturing facilities are being greatly increased.

A. S. Elektrisk Industri, Drammen, Norway, has consolidated with two other concerns in Norway, the Holm-Hansen Elektrisk A. S., Sandefjord and Fridtjoy Andersens Telepointage, Christiania, Norway. The association will continue the manufacture of articles in the electrical line, and will here after conduct its business under the name of the A. S. National Industri with main office at Sandefjord and branch offices at Drammen and Christiania. The association is represented in New York City by Hans Karlsrud, manager of the Drammen branch, 309 Broadway.

Gorham & Goddard Co., 45 W. Congress St., Detroit, Mich., is a partnership formed by L. C. Gorham and A. N. Goddard for the manufacture and salvaging of small tools. Mr. Gorham formerly conducted a business in the salvaging of reamers, end-mills, milling cutters, etc. Mr. Goddard is an expert tool man, and was for four years superintendent of the Union Twist Drill Co., Athol Mass. The new company is equipped with modern tools and will be in a position to give prompt service. It will salvage all kinds of small tools and cutters and also manufacture special tools, dies, jigs, fixtures, gages, special cutters, reamers, end-mills, etc.

Abell-Howe Co., Chicago, Ill., has been incorporated to provide for the expansion of the sales and engineering organization inaugurated some months ago by Oliver J. Abell, 565 Washington Blvd., Chicago. The new company has acquired interests in some of the manufacturing concerns for whose products it will be the national distributor, and in addition it will continue to market other equipment as sales agent. Among the products to be sold exclusively through this company are "American high-speed" chain and Howe "One Man" detachable tongue trucks. Oliver J. Abell is president and treasurer; Glenn G. Howe, vice-president; and C. E. Kane, secretary. Arrangements for representation in the principal distributing centers of the country will be shortly completed.